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BIRD-SONGS IN SPRING.

By Charles A. Witchell.

SPRING, which is not yet a fortnight old, is the best of all seasons for the observation of bird-songs; for what song is not heard at this season? It is not possible to discuss the whole range of the subject—why birds sing now, and how they sing—in one article of ordinary length. More profitable will it be to direct attention to certain important features of song which offer to the field naturalist—nay, to every occupier of a garden—an interesting theme, which has hitherto been systematically investigated by only one or two people. While every physical variation in birds has attracted the fatal attention of ornithologists, the equally interesting variations in voice have been almost wholly ignored; yet the latter, rather than the former, indicate the character of the bird as a living and intelligent animal. It is true that many vocal variations are too slight or too subtle to be definitely described; yet others are of a nature easily indicated.

The most simple feature to record is the repetition of a single cry, uttered either by itself or alternately with other cries. This repetition is the alphabet of bird-song—the primitive method which seems to have governed the development of some of even the most sublime and passionate strains that delight us, as it undoubtedly governs nearly every song we hear. There can hardly be any necessity to quote evidence in support of this proposition, for listening to a wild greenfinch or tree pipit, bunting or wood wren, one hears but a little more than the repetition of one or two notes; and the same feature is noticeable in nearly every other song, including those of the nightingale. It is least evident in the blackbird, blackcap, and robin. But the most easily recorded variations are those in the shortest songs, and in these will local variations be most distinct. The singing of three notes by a cuckoo, for instance, has been recorded; but how often may it have occurred unnoticed? If all the country readers of Knowledge were to listen for this single incident, as opportunity offered, they might establish an important ornithological fact. For they would prove the bird to be capable of attaining a higher (more elaborate) grade of song than its ordinary cry suggests.

To instance a commoner species. The male house sparrow's love call-note, *chissick* (rarely heard except in the breeding season, and then generally uttered near the site of a nest), is dissyllabic; but I have known two sparrows which gave the cry as *chississick*—with three syllables. One of these birds was at Stroud, Gloucestershire; the other is at New Eltham, Kent. The question is, how often does this variation occur? Does it not indicate an advance upon the more simple ordinary note? The cuckoo and house sparrow may quite possibly sometimes give four syllables instead of two, in their cries just mentioned; but until the attention of observers shall have been devoted to this subject, we shall not be able to point to areas in which certain species have relatively advanced beyond their primitive simpleness. There is hardly a species which does not afford in this one feature of bird language a novel subject for study. Has anyone heard a chaffinch, for instance, repeat its alarm note, *fink*, so rapidly as to make of it a single exclamation or phrase? Probably not; yet the chaffinch is always tending towards the development of this variation, and under the influence of fear or anger it repeats the note at very short intervals. The whitethroat (to mention a totally distinct race) has distanced the chaffinch in this progress, as well as in variety of song; for its hard alarm-note, *chick*, is often repeated so quickly that a sort of phrase is produced, such as occurs in the alarms of many other birds, notably in the blackbird, missel thrush, magpie, robin, house sparrow, greenfinch, and great titmouse. The blackcap also has a hard alarm-note, *tuck*, very like that of the whitethroat, and often uttered; but only twice have I heard it reiterate this cry rapidly in the manner of a whitethroat. On both of these occasions the bird was very much alarmed; and the intensifying of its emotions caused an increased rapidity of the cry in which they were expressed—a common incident in animal life. But the chaffinch, even when terrified, has never to my knowledge uttered a phrase of alarm instead of its ordinary single cry.

It may be well to mention here a local variation in the voice of the chaffinch, which seems not to have been recorded. I have observed it near Eltham, Kent, and nowhere else. Had it occurred only once or twice it would not have been very remarkable, but I noticed it in about twenty birds, all males; and a more important circumstance is that the note is undoubtedly used partly to express alarm. In "The Evolution of Bird-Song" I have contended that the alarm-notes of allied birds are the most similar, and that they are of more remote origin than songs, which more often vary individually; this note of the chaffinch is therefore especially interesting.

At the beginning of April last year a strange loud note

could often be heard from the thickets, even through the charm of birds there, and it had always the same tone. It was heard at no particular time of day, but often alternated with the *fink* or *whit* of the chaffinch. Several weeks passed before the bird uttering this note was clearly visible as the male chaffinch, and I have no doubt the occurrence had throughout been limited to this species and sex. The cry was remarkably distinct. It could be well suggested by *zee*, and in tone closely resembled the coarse final song-note, *zshee* or *zshwees*, of the greenfinch; but it was not one-half so long as this sound. It also resembled the short note *jink* which the male yellowhammer often utters contentedly from an elevated perch. It was never uttered in my hearing by the female chaffinch, nor by the young. At the end of June it was once slightly varied, and I have no record of it after that month. It was obviously used partly as an alarm note, for I heard it employed, together with the *fink*, to rate a jay, a dog, and, I think, myself. The note was also given in the song, but only at one particular part of it, which will be indicated. Dr. A. G. Butler informs me that the song of the chaffinch is popularly supposed to suggest the words written under the following notation, which is intended to represent the general run of the song:—

Sometimes the penultimate note, the hard "wheat," is replaced by a double sound, so that the "wheat-ear" sounds like "tissicar," and sometimes these last syllables are themselves doubled. In this particular the chaffinch exhibits the common feature of greater variation at the end than at the beginning of a song. I have often noticed that the hard note "wheat" is emphasized variously by different chaffinches, being sometimes prominent, and, in other birds, hardly audible.

When the cry *zee* is given in song it takes the place of the hard "wheat," and terminates the strain, which may then be rendered: "In another month will come a zee." There is never a note after the *zee*, which, indeed, seems to require some effort, for when it is given alternately with the *fink* or the *whit*, there is a slightly increased pause before the *zee*, and a longer one after it.

I have always considered the hard note "wheat" as having a family resemblance to certain coarse notes of the greenfinch, lesser redpole, and some other finches; and it is quite possible that the *zee* is a survival from an earlier type of song, in which the chaffinch uttered a few preliminary hurried notes followed by a coarse note, in the manner of a greenfinch. The notes of the chaffinch have been here discussed at some length as serving to indicate a method of observation which may usefully be followed in the study of bird-song. I may add that Mr. Holte Macpherson also heard the new note, and considered it to be a local variety.

The family resemblance between the voices of allied species may be easily investigated in spring, when songs and alarms are heard from every side. It is most noticeable in alarms and call-notes. In the warblers, for instance, we hear a short hard note, *tack*, slightly modified in the blackcap and the whitethroats; and a low *curr* of warning, which I have once heard from the blackcap, but which is a common utterance of the nightingale, sedge warbler, and the whitethroats. The love-calls are equally interesting, and are sometimes given in the course of a characteristic flight, such as the straight, cuckoo-like flight of the male chaffinch, the slow fanning flight of the greenfinch, and occasional extravagant evolutions of a titmouse.

But the most fascinating feature of bird-song is the mimicry often incidental to it. At first this is not easily detected, probably because our previous experiences of the kind have been limited to the performances of parrots. The parrot seems to make a special effort to mimic, but most song-birds appear to repeat the notes of others merely as a means of varying their own songs. One or two, however, such as the starling and sedge warbler, seem to mimic intentionally, and it is to these that the observer should first attend. By practice his hearing will be enabled to follow the rapid vocalization of these birds, and will become acute to recognize their often exact mimicry. The skylark next, and afterwards the thrush, robin, and whitethroat, may be listened to with the conviction that occasionally an excellent imitation will be perceived. On the other hand, but a little mimicry will be observed in songs of the wild linnet and goldfinch; and not once in a year will it be found in any other British finch, nor in our buntings, pipits, wagtails, titmice, hedge sparrow, or wren, although several of these birds will imitate when kept in a cage. The difficulty in observing may be the reason why bird-song as a subject for scientific investigation has been neglected, and why ornithologists have generally dismissed in a brief sentence or two the songs of their favourites, and have only quite recently done justice to the clever music of even the best mockers.

The thrush is not nearly so mimetic as the sedge warbler and the starling, but the accuracy of which it is capable in this respect may be inferred from the following incident. One May day at Stroud I was listening to a thrush, and was naming its imitations, as they occurred, to my brother, Mr. E. N. Witchell, he being much interested in birds and their ways. The thrush several times repeated very clearly a call-note of the butcher-bird, with which my brother was not acquainted. On the next day he was crossing Painswick Hill, and suddenly heard behind him a repeated cry, which he at once recognized as that which the thrush had uttered in its song. Turning, he saw a butcher-bird coming lilting along behind him, quite in the open, so that there could be no doubt of its having uttered the cry in question.

ENGLISH MEDALS.—I.

By G. F. Hill, M.A.

THE most obvious feature of the history of the medallic art in England is that the great majority of pieces of any artistic importance were produced by foreigners. Out of a total of some two hundred medallists working before 1760, whose medals illustrate English history, hardly more than twenty-five were Englishmen. Even at the present time, when there has been a slight revival in the art—although unfortunately too limited—the man to whom it is due bears a French name. Nor can it be said that England succeeded, as a rule, in impressing an English character on the art of the foreigners who worked for her. There has never really been an English school of medallists of any excellence, except, perhaps, at the time of the Commonwealth.

Of the medals* relating to English history, the earliest are two curious French pieces struck by Charles VII., and recording the expulsion of the English from France in 1451. The date is expressed chronogrammatically, *i.e.*,

* From this series must be excluded all counters or tokens, and pieces which serve a purpose other than purely commemorative.

by adding together those letters in the legend which have a numeral significance.

The first Englishman to appear on a medal was John Kendal, Lieutenant of the Grand Master of the Knights

John Kendal, 1480.

of St. John, Grand Prior of the Hospital in London, and Turcopellier, or commander of the cavalry against the Turks. The medal (Fig. 1) is by an Italian hand, and bears the date 1480.

The medallic series, however, does not really begin until the time of Henry VIII. Then we have a series of contemporary portraits, as of Anne Boleyn, Thomas More (No. 1), Thomas Cromwell, and Henry VIII. himself (after a portrait by Holbein). The portraits are powerful, though often lacking in finish. They are usually cast, and, in some cases, chased. Struck medals do not become common until the seventeenth century. The fine portrait of Michael Mercator, or Michael of Gueldres, who was often in England on diplomatic business, can hardly be called an English medal, as it was executed by himself; but it is illustrated (Fig. 2) in order to show the difference between Dutch and English work at this time. It is of silver, cast and chased.

Besides the portrait medals, we have, in the reign of Henry VIII., one medal of historical importance, which records Henry's title as Supreme Head of the Church: FIDEI DEFENSOR ET IN TERR. ECCLE. ANGLI. ET HIBE. SVB CHRIST. CAPVT SVPREMVM. The inscription is repeated in Greek and Hebrew on the reverse. The medal is dated *Londini*, 1545, but the title had been confirmed by Parliament in 1534.

A somewhat similar triple inscription occurs on the first of English coronation medals, recording the coronation of Edward VI., on the 20th February, 1547.

To the connection of England with Spain in the reign of Mary are due a number of medals by Jacopo Trezzo, an Italian, who worked at Madrid in the service of Philip II. His style is well illustrated by a medal with portraits of Philip and Mary. The piece here illustrated (No. 2) is a small replica of a larger medal, and is of very fine workmanship.

With Elizabeth, we enter on the most interesting century in the medallic history of England. The Italian medallist is still *en évidence*—one of the finest pieces being the portrait of Mary Queen of Scots by Jacopo Primavera (No. 6). But undoubtedly the most important medals are those relating to the Spanish Armada, and these are of English workmanship.

They represent on the obverse the bust of the Queen in very rich attire, with sceptre and orb, and the motto DITIOR IN TOTO NON ALTER CIRCVLUS ORBE. The field of some specimens is delicately ornamented with an engraved floral design. On the reverse is an island, on which stands a bay tree; in the background a city. Round the island a storm is raging, but, as the motto says, NON IPSA PERICULA TANGVNT (No. 3). The medal was cast and elaborately chased. The bay tree was supposed not only to be incapable of suffering injury from lightning, but also to provide immunity from various ills, such as falling sickness and devils. Another variety of this medal has on its reverse an ark riding quietly on the stormy waves: SEVAS TRANQVILLA PER VNDAS. The name of the English flagship on the occasion of the defeat of the Armada was the *Royal Ark*.

These medals both record the defeat of the Armada, but the former is also significant of the fact that other dangers were averted. "The Queen of Scots was dead; James of Scotland had been conciliated; the Duke of Guise was dead, and France and the Vatican were baffled."* It will be noticed that these medals are made with a loop for suspension, and a specimen in silver in the British Museum has the original chain attached to it. In fact, there is little doubt that these pieces, which were made in all three metals, were distributed as rewards. We thus have in them the prototype of our later war medals.

The style of these pieces is clearly not equal to that of the Italian or Dutch work of the time, but it nevertheless—especially as seen in the elaborate decoration of the bust—has a certain barbaric splendour.

Among the portraits of the period, one of Mary Queen of Scots, by the Italian Giacomo Primavera, has already been mentioned. Most interesting are a series of portraits by Stephen of Holland, who executed a considerable number of private commissions when he was in England, chiefly in the year 1562. The portrait of Maria Newce

Michael Mercator, by himself.

(No. 4), the wife of John Dymock, is characteristic of Stephen's neat and tasteful style.

The medals of the reign of James I. are of comparatively small interest, with the exception of certain portraits and one small medal (No. 5), of Dutch workmanship, which commemorates the discovery of the "Gunpowder Plot." On the obverse is a snake among lilies and roses: DETECTVS QVI LATVIT. S.C. On the reverse is the radiate name of Jehovah within a crown of thorns, and the chronogrammatic motto: NON DorMItasti antIstes IaCobI. The medal was struck in Holland by order of the Senate (hence the letters S. C., *Senatus consulto*, on the obverse).

One of the finest portraits of men of the Jacobean age is that of Sir Thomas Bodley, founder of the Oxford University Library (No. 14). In this case the medal is by a Frenchman, Jean Warin; but as Warin was born

* "Medallic Illustrations," I. p. 154.

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only eight years before Bodley's death in 1612, the medal is much later. The material is lead.

A series of beautiful portraits, produced in a peculiar manner, were made in England in the reign of James I. by Simon Passe, of Utrecht. These portraits have the appearance of being engraved on thin silver plates; but, as a matter of fact, they are stamped from metal dies, as is proved by the fact that several copies of the same portrait exist which are line for line the same. It is not unusual to find counters produced by the same process, although in some cases each piece was separately engraved.*

The reign of Charles I. saw the rise of some new artists, notably Nicholas Briot and Thomas Rawlins. The work of these artists, who were employed on the English coinage as

Charles I., by Briot.

well as in making medals, has been sufficiently discussed in a previous article.† But the fine portrait of Charles, executed in 1630 by Briot for the obverse of a medal asserting the claims of England to the command of the seas, can hardly be passed over here (Fig. 3). Besides what may be called the series of official medals, there were produced during this reign an enormous number of badges with portraits of the leaders of both parties in the Civil War. Thus we have (No. 9) a fine memorial badge with the likeness of Robert Devereux, Earl of Essex (whose name is on some specimens represented by the letters S X). The reverse bears his arms and the date of his death (14th September, 1646). Other badges of Essex were given as military rewards; and there are similar rewards bearing portraits of Fairfax, Sir William Waller, Prince Rupert, and others.

But most numerous are the Royalist badges which were made and worn as memorials of Charles I. One of the finest (the reverse of which represents Queen Henrietta Maria) is that of which No. 10 illustrates the obverse, and which is from the hand of Thomas Rawlins.

There exists a unique gold piece by Rawlins, which is generally reputed to have been presented by Charles I. to Bishop Juxon on the scaffold. This is, in reality, not a medal, but a pattern for a five-broad piece. The work is by no means of the highest order, and the enormous price which the piece has fetched must be ascribed to its sentimental rather than to its artistic value.

The series of medals illustrating the reign of Charles I. may be closed with a fine and characteristic portrait of Archbishop Laud (No. 7). The well-known medal commemorating this prelate's death, with the somewhat ludicrous design of infant angels carrying to heaven his mitre and crozier, and the crown, sceptre, and orb of Charles I., is of later date, having been made by J. Roettier after the Restoration.

With the Commonwealth, the medallic art in England comes to its culmination, to decline again but too soon. At this time there were working for the Government the brothers Abraham and Thomas Simon. The Simons have been claimed as Englishmen—and, indeed, their work may really be said to bear the national character imprinted on it; but their origin was probably French, and can certainly be traced as far as Guernsey. Of the two brothers, Thomas has the greater reputation; but it is stated on the best authority that the many portrait-medals signed by Thomas are all from models made by his brother. We have, however, a number of medals signed by Abraham himself. As a specimen of the combined work of the two brothers may be mentioned the fine portrait (No. 8) of Bulstrode Whitelock, Lord Keeper of the Great Seal of England, Constable of Windsor Castle, High Steward of Oxford, made in his forty-ninth year (1653). Abraham's models were made in wax, and some of them are still extant.

This must suffice for an illustration of the style of Thomas Simon in portraiture. Of his medals of a different kind only a few can be mentioned. The battle of Dunbar is commemorated on an oval piece (No. 11), with a fine bust of Cromwell on the obverse (legend: THE LORD OF HOSTS. WORD AT DVNBAR. SEPTEM. Y. 3, 1650; signed T. SIMON F.), and on the reverse a view of the Parliament assembled in one house with the Speaker. This medal was struck for distribution among the officers and soldiers of the army. The brilliant services of the fleet against the Dutch in February, June, and July, 1653, were rewarded by a medal which ranks among the finest of the English series. There are several varieties, but all bear the same design (No. 12). The three shields are for England, Scotland, and Ireland; on the reverse is a naval fight. The medal is signed by Simon on the stern of the sinking vessel (SIMON), and on the prow of another (T. S.). Specimens of these medals, with broad borders of trophies and valuable chains, were presented to Admiral Blake, General Monk, and Admirals Penn and Lawson; four others, with narrower borders of laurel leaves, and chains worth £40 each, to the four flag officers. The sailors who saved the *Triumph*, Blake's flagship, were rewarded with this medal, bearing engraved a commemorative inscription: FOR EMINENT SERVICE IN SAVING Y TRIVMPH FIERED IN FIGHT WH Y DVCH IN JVLY, 1653. It is one of these specimens that is illustrated here (No. 12). The workmanship of these medals is beyond praise, and will bear without difficulty the crucial test of enlargement. They are, in fact, quite equal, if not superior, to the best Dutch medals of the time.

With Simon's war-medals should be compared the fine Wyard medal, which has, indeed, been attributed to Simon (No. 13). Wyard, in a ship of twenty-two guns, beat off six Irish frigates, carrying a total of one hundred and eighteen guns; and his crew were rewarded with a medal somewhat similar in design to the Blake medals.

Here we may close the first chapter in the history of English medals. The second chapter may be longer, and the medals thrice or four times as numerous; but, from an artistic point of view, the best period in the medallic history of England is included, roughly speaking, between the dates 1560 and 1660, and closes with or soon after the Restoration.

* The nature of Passe's work unfortunately precludes the representation of any specimen of it in the accompanying plate.

† *See* Knowledge, October 1st, 1896, p. 218.

ENGLISH MEDALS.

ON THE PROGRESS OF CHEMISTRY AND THE CHEMICAL ARTS DURING THE QUEEN'S REIGN.*

By Professor Thorpe, LL.D., F.R.S.

CHEMISTRY as an art has been practised from time immemorial, and a great variety of what are, strictly speaking, chemical products, such as metals, salts, acids, dyes, pigments, were made long before the Christian era. Chemistry as a science, however, is barely a century old. It is based upon the Atomic Theory, and the idea of explaining chemical phenomena by means of the conception of atoms, foreshadowed by Newton, and more clearly adumbrated by his followers Kiel, Hartley, Marzucchi, and Higgins, was first definitely stated by John Dalton during the first decade of this century. The whole course of modern chemistry, however complex and many-sided it may seem, is really one vast elaboration of the Atomic Theory. As Liebig has said: "All our ideas are so interwoven with Dalton's theory that we cannot carry ourselves back to the times in which that theory did not exist." And yet this fundamental hypothesis, as understood by chemists, had barely come of age when the Queen came to the throne; it was not much older at the time than she herself. The illustrious philosopher who first gave precision to this idea was still living, but stricken down at the time by the paralytic attack, the beginning of the brain disintegration which seven years later ended in his death. Sir Humphry Davy—a younger man than Dalton—the pioneer in the then recently-discovered field of electrochemistry, and which to-day is yielding such splendid fruit, had been dead only about eight years, as were Wollaston and Thomas Young. All three, in fact, died at about the same period, and all from affections of the brain. At the Royal Institution he who has been styled the greatest of Davy's discoveries reigned in Davy's stead. Michael Faraday of revered memory—blacksmith's son, newspaper boy, bookbinder's apprentice, and Fullerian Professor of Chemistry—was then in his forty-fifth year, in the full maturity of his intellectual power, and near the meridian of his scientific glory. All his more important work in chemistry—his discovery of benzene, his researches on the liquefaction of the gases—had been accomplished, and he was almost wholly engaged upon those great problems of electrical science which have made the extraordinary development of applied electricity, as we see it to-day in electrolytic decomposition, in the electric light, and in the application of electricity as a source of power, alone possible. The Queen, in fact, may be said to have witnessed the birth of this marvellous application of natural energy, to have lived with it through its vigorous youth, and to have seen the promise of a fruition so vast that no man can set bounds to it. Think of the simple experiments out of which has grown the mighty machinery of modern industrial electricity! Try to realize the difference between Faraday's simple home-made apparatus—his small copper discs, his bits of soft iron wound with wire insulated with calico and twine—and the mighty dynamos which are converting the energy of a "harnessed" Niagara into heat and light and chemical action, and supplying power to a continent! And all this within the span of a single reign—within the compass of a couple of generations. This astonishing movement is what historians will ever recognize as the characteristic feature of the Victorian era. It has wholly changed the economic and social condition, not only of our people, but of every country which has had the intelligence and the wisdom to participate in it, or the sagacity to avail itself of its fruits. It has reacted not only upon industry, but on every department of intellectual effort. It has changed, although hardly with a commensurate rapidity—for there is no class so conservative as that of the schoolmaster—the face of our educational system. To judge what the change has been, let us try to realize how chemistry was taught in this country in 1837. As a part of school education it was practically unknown, although children whose parents had the good fortune to be influenced by the teaching of such far-sighted men as Mr. Edgeworth, had their curiosity stimulated and fed by occasional lectures on science. As regards the older universities, at Oxford there was Dr. Daubeny, an amiable and accomplished gentleman, who was a professor of botany to chemists, and a professor of chemistry to botanists; at Cambridge, there was Prof. Cumming, who lectured on chemistry, but interested himself mainly in electricity. At neither place was there anything in the nature of a laboratory which the student could attend. If the enterprising undergraduate desired to familiarize himself with the facts of chemistry by practical experiment, or sought to try and work out an idea which might have occurred to him, he had to pursue his inquiries in his own rooms and with such apparatus as his means or his opportunities could command, to the imminent risk of his furniture and to the dismay and disgust of his bedmaker. It was under such conditions that the late Sir John Herschel discovered the solvent action on silver salts unacted upon by light of what the photographers know as "hypo" (sodium thiosulphate), and thereby made photography possible.

In Scotland, Dr. Hope—whose name carries us back to the days of phlogiston—still enjoyed at Edinburgh the fame as a lecturer which he shared with Davy at the Royal Institution; but no tuition in practical chemistry, as a part of university training, was ever thought of. Matters at Glasgow were a little better, and Thomas Thomson would occasionally extend a brusque hospitality to the student who aspired to the art and mystery of mineral analysis, but no systematic instruction was ever attempted. The youth with no knowledge of manipulative work, and with scarcely an acquaintance with the forms even of chemical apparatus, was regarded as a sort of laborant, and might be set, at the very outset, to struggle with a zeolite, or to grapple with an atomic weight determination, as best he might. This circumstance probably serves to explain the character of much of the analytical work which is connected with Thomson's name, and which, happily enough, has passed into oblivion.

In London there was the promise of better things. Thomas Graham—who had already made his memorable discovery of the law of gaseous diffusion whilst Professor of Chemistry at Anderson's College in Glasgow, where he had established a school of practical chemistry, and

* From an address delivered at the East London Technical College, People's Palace, on the occasion of the distribution of science certificates, February 8th, 1897. With additions.

where he had as students the late James Young, whose name is linked with the creation of the Scotch paraffin oil industry, and the present Lord Playfair — had followed Ure and Birkbeck to London, and had been elected to the chair of chemistry at University College, Gower Street, up to that time known as the University of London. Here as successor to Edward Turner, a painstaking and even brilliant manipulator, whose atomic weight work rivals that of Berzelius in point of conscientious accuracy, he created the School of Chemistry which, aided by Fownes and Williamson, he made famous throughout Europe.

But it may be doubted whether in 1837 there were more than a couple of dozen persons altogether in the British Isles receiving systematic instruction in practical chemistry, and even that supply was probably fully equal to the demand. There was, in fact, little to tempt men to take up the study or practice of chemistry as a means of livelihood. Professorships or teacherships were few in number and poorly paid; analytical chemistry, as a profession, barely existed, although the "expert," *pace* Ure, was not altogether unknown; and chemical manufacturing was, for the most part, in the hands of men to whom chemistry was an empirical art. How things appeared to an intelligent and keen observer is well illustrated by one of Liebig's letters to Berzelius, in which he recounts his impressions of England, which he had just visited. Under date November 26th, 1837, Liebig tells the Swedish chemist that he had been some months in England, had seen a vast amount, and learnt little. England, he says, is not the land of science; her chemists are ashamed to call themselves chemists because the apothecaries had appropriated the name. He was extraordinarily pleased with us as a people and delighted with our hospitality and welcome, but as regards our chemists—well, Graham was the only exception, and he was precious. Liebig evidently considered that Faraday could no longer be reckoned among the chemists.

But a little leaven was leavening the whole lump, and that leaven was Liebig himself. Aided by the far-sighted munificence of a German prince, he had succeeded in establishing the little Giessen laboratory, and thither every seeker after chemical truth and every aspirant for chemical fame bent his steps. Among these early chemical pilgrims were Lord Playfair, Sir Henry Gilbert, Prof. Williamson, Dr. Gladstone—all happily still among us. Others might be named, but the greater number have now passed away. All of them, whether great or small, brought back from Giessen something of the spirit and method which have made the little laboratory on the banks of the Lahn famous in the history of chemistry. The influence of Giessen has been as a seed which, falling on good ground, has sprung up and multiplied an hundredfold. That influence has made Germany pre-eminent in the world of scientific chemistry, and may make her pre-eminent, if it has not already done so, in the world of industrial chemistry. Luckily for this country, Liebig's influence has reacted also upon us. It has had a profound effect on chemical activity, and on the development of chemical teaching in England. One of its first results was seen in the founding, in 1841, of the Chemical Society, whose duty and privilege it is to foster chemical inquiry and promote the spread of chemical knowledge. The Society now numbers upwards of two thousand members. How it is achieving its purpose may be seen in the activity and interest of its meetings, in the extent and value of its publications, and in the helpful hand it extends to the investigator by the prudent administration of the funds which have been placed at its disposal by the munificence of private benefactors and public bodies.

Another notable result of Liebig's influence on chemistry was seen in the foundation, in 1845, of the Royal College of Chemistry, of which Hofmann, one of his most distinguished pupils, was invited to take charge—thanks largely to the action of the late Prince Consort. What Hofmann, fired by the example of Liebig and his own innate enthusiasm, did for chemistry in England may be seen in the panegyric of Hofmann—the joint work of Lord Playfair, Sir Frederick Abel, Dr. Perkin, and Prof. Armstrong, which appeared some little time ago in the *Journal of the Chemical Society*. There is no more inspiriting or instructive chapter in the history of chemistry in this country than that which records the work of the Royal College of Chemistry, and traces its influence on the development of pure and applied science. Although Hofmann unfortunately left us, his spirit and example still remain and actuate us. This spirit has been carried into a hundred places of chemical instruction and research in these islands. Let us pray that it may continue and increase, for it is on its continuance and growth that the development of chemical science and chemical industry depends; and in so far as our national prosperity is connected with the chemical arts our national prosperity depends on it also.

It is hardly necessary nowadays to show how closely the wellbeing of a community is connected with the chemical arts. Chemistry and its applications concern us at every turn, for there is scarcely a single industrial operation which could be named with which this science has not some relations, either proximately or remotely. There is a noble passage in one of Sir Humphry Davy's earlier lectures which well illustrates this point. The lesson has been frequently urged upon us, but never more forcibly than by Davy at the very beginning of this century. It is not often that the theatre of the Royal Institution resounds with more eloquent sentences than these :—

"The progression of physical science is much more connected with your prosperity than is usually imagined. You owe to experimental philosophy some of the most important and peculiar of your advantages. It is not by foreign conquests chiefly that you are become great, but by a conquest of nature in your own country. It is not so much by colonization that you have attained your pre-eminence or wealth as by the cultivation of the riches of your own soil. . . .

"In every part of the world manufactures made from the mere clay and pebbles of your soil may be found; and to what is this owing? To chemical arts and experiments. You have excelled all other people in the products of industry. But why? Because you have assisted industry by science. Do not regard as indifferent what is your true and greatest glory. Except in these respects, and in the light of a pure system of faith, in what are you superior to Athens or to Rome? Do you carry away from them the palm in literature and the fine arts? Do you not rather glory—and justly too—in being in these respects their imitators? Is it not demonstrated by the nature of your system of public education and by your popular amusements? In what, then, are you their superiors? In everything connected with physical science — with the experimental arts. These are your characteristics. Do not neglect them. You have a Newton, who is the glory, not only of your own country, but of the human race. You have a Bacon, whose precepts may still be attended to with advantage. Shall Englishmen slumber in that path which these great men have opened, and be overtaken by their neighbours? Say, rather, that all assistance shall

be given to their efforts; that they shall be attended to, encouraged, and supported."

These words were spoken in 1809, and during all the turmoil and political disquietude that marked the opening years of the century. However willing and receptive the ears, the time was inopportune. The minds of the auditors might be convinced, but their energies were preoccupied with the arts of war rather than with those of industry and peace. A generation later, and when Europe had settled down after the fall of Napoleon, Davy's teaching began to bear fruit. We have seen how far it had matured at the time of the Queen's accession, and in the years immediately subsequent to it: how far has it been attended to and supported since?

As regards chemical education the difference is enormous. There is not an important town in the kingdom in which chemistry is not taught, and, on the whole, well taught. Almost every manufacturing town in the country can show a public chemical laboratory far better equipped with appliances for teaching, and even research, than were the most famous laboratories of sixty years ago. In the matter of the introduction of the teaching of physical science into our schools, the force of public opinion is gradually making itself felt, although the head master, as a rule, hardly yet realizes the full significance of Faraday's weighty words when he said: "I do think that the study of natural science is so glorious a school for the mind that, with the laws impressed on all created things by the Creator, and the wonderful unity and stability of matter and the forces of matter, there cannot be a better school for the education of the mind."

Things, however, have improved since the time that Faraday told the Public School Commissioners that the fact that the natural knowledge which had been given to the world in such abundance was untouched, and that no sufficient attempt was being made to convey it to the young mind, growing up and obtaining its first views of these things, was to him a matter so strange that he found it difficult to understand. The opposition which Faraday felt was so difficult to overcome, but which, he added, he had not the least doubt in the world ought to be overcome, has been to some extent relaxed, and, in the curt but characteristic language of the forms, "stinks" are at least tolerated, even if they are not encouraged, in the curricula of most public schools. It is, however, in the newer provincial colleges that the teaching of chemistry has received its greatest development. Owens College, Manchester, founded more than forty years ago, has become, mainly by the influence and organising power of Sir Henry Roscoe, and of his successors, Profs. Dixon and Perkin, one of the foremost schools of chemistry in the country. The great success of Owens College has stimulated almost every large town to provide itself with an institution of similar character, and colleges of university type, all of them with well-equipped chemical laboratories, are now to be found in Liverpool, Leeds, Newcastle, Nottingham, Sheffield, Birmingham, Bristol, Cardiff, Aberystwith, Bangor, and Dundee. Institutions of a less ambitious type, although provided for the most part with good accommodation for instruction in practical chemistry, are met with, amongst other places, at Bradford, Huddersfield, Preston, Oldham, Chester, Newcastle-under-Lyme, Portsmouth, Southampton, Camborne, Edinburgh, and Glasgow. All the older universities have followed suit. The university laboratory at Cambridge is one of the best arranged in the kingdom; Edinburgh is also admirably provided with the means of pursuing research in the higher branches of the science, as are the recently opened laboratories of St. Andrew's and Aberdeen. With the exception of University and King's Colleges, and the Royal College of Science (into which has been merged the chemical teaching of the Royal College of Chemistry and of the Royal School of Mines in Jermyn Street), all the more important schools of chemistry in London are comparatively modern. The City and Guilds Institute in South Kensington, built in 1883, and the associated Institute in Finsbury, erected a short time previously, owe their origin to the action of the City companies, who have been instrumental also in founding or in assisting a number of the Polytechnics scattered round London, such as the Goldsmiths' Institute at New Cross, the Battersea Polytechnic, and the East London Technical College, which has its home in the People's Palace. A great number of the Polytechnics and minor colleges above named are dependent upon aid from the Department of Science and Art, or are supported by funds at the disposal of County Councils. Indeed, the liberation of the "beer" money, and its very general application to so-called technical education, has had a very marked effect in diffusing a knowledge of the elementary principles of science. Whether the money is in all cases spent to the best advantage may be open to question. There is, indeed, little doubt that more real good might be accomplished by a better method of allocating the amount, as, for example, by some system of co-ordinating County Councils within specified areas, with a view of subsidizing secondary schools and the colleges of university type situated within the area. This, however, as a part of the general question of what is the best method of dealing with secondary education in this country, is too complex a matter to be dealt with now. It is pretty plain that before many more years have passed a Parliamentary inquiry will be demanded on the working of the present method of allowing each County Council to do practically what it likes with what it imagines to be its own.

No record of the educational work in science of the last sixty years would be complete without some reference to South Kensington. The system and its results have been, at times, the subject of much hostile, and, it must be added, not very well informed or altogether impartial criticism. But I venture to think that any dispassionate and unprejudiced inquirer, who will take the trouble to make himself master of the subject, will be constrained to allow that the Department has done great and permanent service to the cause of scientific education in this country. The general standard of scientific knowledge has been enormously increased by the hundreds of science classes created by its agency, and which otherwise would have been non-existent. How far it will be allowed to continue on its present footing remains to be seen. It is, however, certain that the science teaching which it has called into existence, and which it has fostered and encouraged, is too much an integral and essential part of our educational system to be abolished, whatever may be the machinery of State by which it is to be directed and controlled in future.

What Englishmen of science have done in the way of chemical inquiry and discovery during the Victorian era, the pages of the *Philosophical Transactions*, and of the *Journal of the Chemical Society*, abundantly indicate. The names of Faraday, Graham, Williamson, Hofmann, Frankland, Miller, Schunck, Stenhouse, Brodie, Andrews, Gladstone, Crookes, Perkin, De la Rue, Müller, Roscoe, Schorlemmer, Rayleigh, Ramsay, Dewar, are associated with experimental investigations which mark points of departure in the history of chemical progress during the last sixty years. These investigations range over every department of chemical inquiry, from the isolation of new elements—the preparation of new compounds of great

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theoretic and industrial importance—to the discovery of new generalizations, and the recognition of important physico-chemical laws.

As regards originality in the application of chemistry to practice, our record is hardly less brilliant, although in too many cases it has been given to other nations—and in particular to Germany—to gather the fruit which ought to have been ours. It is interesting to note that the ammonia-soda process was patented by Dyar and Hemming in the first years of the Queen's reign, and was worked by the Muspratts as early as 1839; but it was left to two Belgian engineers to secure for this method of manufacturing alkali the great commercial success which it now enjoys. The discovery of benzene by Faraday was the first step in the history of the coal-tar colour manufacture; the second step was taken by Mansfield, at the sacrifice of his life, in working out the industrial isolation of the hydrocarbon; whilst the third was due to Perkin, when, by the discovery of mauve, he revealed the enormous wealth of colouring matter which was latent in coal-tar. In spite of the labours and example of Medlock and of Nicholson, the importance of this great branch of industrial chemistry was not recognized by manufacturing chemists in this country, and its present extraordinary development is due to Germany, which has spent upon it some of the ablest chemical talent it possesses. It is rather by the development and extension of well-established processes, depending on comparatively simple chemical principles, that our progress in the chemical arts is to be measured; for our staple chemical industries remain very much what they were at the beginning of the Queen's reign. The industrial chemistry of chlorine may be said to have been worked out by Englishmen, and the names of Gossage, Weldon, and Deacon are pre-eminently associated with the growth of this branch of chemical manufacture. The Muspratts manufactured Liebig's patent manure in 1843, and this marks the beginning of the large trade in chemical fertilizers which has been entirely developed during the Queen's reign. Perhaps the best measure of the progress of applied chemistry in this kingdom during the past sixty years, may be gathered from the difference in the amounts of oil of vitriol manufactured in 1837 and at the present time. The great value of sulphuric acid as an index of the prosperity of the chemical arts arises from the circumstance that there is no other single chemical product that is so largely concerned in the manufacture, directly or indirectly, of other chemical substances. To-day sulphuric acid is manufactured with an almost quantitative precision, thanks very largely to the introduction of the Glover tower, which it is not too much to say effected a revolution in this great industry.

What the future has in store for us remains to be seen. The more general introduction of electrical processes into chemical manufacturing is bound to effect great changes. The application of electrical energy has completely altered the aspect of the metallurgy of aluminium, copper, and the alkali metals, and it now threatens the supremacy of the established methods of manufacturing alkali and chlorine.

So far as can be seen, there is no immediate hope that this country will be able to compete with Germany in the manufacture of those products which are the direct outcome of the application of the higher and more recondite branches of chemical science to industry, nor will there be even the prospective hope until our manufacturers, as a body, bring the spirit of science into their work, and show a greater receptivity and a more widespread desire to turn the ever-growing development of the science to practical account.

AN ARCHAEOLOGICAL SURVEY OF THE UNITED KINGDOM.*

IT is not given to us all to cultivate that sublime enthusiasm for the crumbling relics of our prehistoric past which actuates Dr. Murray in this most admirable and invaluable address. Originally delivered as a presidential address to the Glasgow Archaeological Society, it is here reprinted from the *Transactions* as a permanent collection from many sources of much curious information on the rise and progress of the science. But it is more than that. Step by step, through a clear and perfect narrative of the facts, by comparisons with other lands, and contrasts with kindred sciences in our own, the author has compiled an unanswerable appeal to the Government to project a complete archaeological survey of the United Kingdom, similar to the topographical and geological surveys. Such a survey has been in progress in India for more than thirty years, and a minute signed by Lord Canning, in 1862, thus tersely sets out its purpose: "What is aimed at is an accurate description, illustrated by plans, measurements, drawings, or photographs, and by copies of inscriptions, of such remains as most deserve notice, with the history of them so far as it may be traceable, and a record of the traditions that are retained regarding them." In France, so far back as 1831, M. Guizot, then Minister of Public Instruction, founded a commission for the conservation of national monuments. In Denmark, Prussia, and Bavaria, similar work has been done; while the interesting memoirs issued from time to time by the Bureau of Ethnology of the Smithsonian Institution on many prehistoric monuments throughout the United States of America, are well known.

Such a project, then, in our country, is eminently practicable, perfectly reasonable, and absolutely necessary. It should be pressed upon the Government by every friend of archaeological science that a work of such magnitude and importance should be no longer neglected and delayed. Let us at once and for ever, as Dr. Murray so well puts it, "wipe away the reproach that England is the only country in Europe that does nothing to register and protect her ancient monuments." The condition of the law in regard to the question is simply farcical. Sir John Lubbock's Ancient Monuments Protection Act (45 and 46 Vict., cap. 73) was limited to a defined list of only sixty-nine monuments in all (twenty-nine in England, twenty-one in Scotland, and nineteen in Ireland); but it set up certain machinery by which the Commissioners of Works are empowered to receive, by bequest or purchase, any ancient monument, and some few additions have been so made to the original list. But, incredible as it may appear, even this slow and feeble method of preserving the undesigned records of the past has been rendered inoperative by the Government, who decline to accept further monuments under the Act. An excellent example of how not to do it.

In deploring the loss of the exact local pronunciation of place names, Dr. Murray presses the phonograph into the service, and advocates a phonological museum for the purpose of recording reliable information as to place names. An admirable suggestion, which should also serve the philologist. The author further suggests the founding of local museums for the retention of antiquities in the localities to which they belong, and he condemns the sacrifice of all local interests to the one purpose of a national collection. "Because the county of Northumberland is politically in

* "An Archaeological Survey of the United Kingdom: the Preservation and Protection of our Ancient Monuments." By David Murray, LL.D., F.S.A. (Glasgow: James MacLehose and Sons.)

England is surely no reason why its antiquarian remains should be transported to London." We heartily sympathise with this view of decentralization in archaeology, providing there is some system of recording at the central institution the treasures thus locally cared for.

For the purpose of defraying the cost of the survey, and also forming a fund sufficient to protect the monuments, Dr. Murray proposes to ear-mark the funds arising from the estates of intestates reverting to the Crown. We do not care for ear-marked funds, and should prefer to leave the ways and means to the Chancellor of the Exchequer. One question remains. Where is the enterprising Member of Parliament who will make this question of an archaeological survey his own?

The address is accompanied by three most valuable appendices: (*a*) Questions addressed to its correspondents by the Comité Historique des Arts et Monumens; (*b*) the law as to injury to ancient monuments in England, France, and Germany; (*c*) an admirable summary of the law as to treasure trove.

THE MAPLE MOULD.

By Rev. Alex. S. Wilson, M.A., B.Sc.

On the leaves of the plane tree or sycamore our readers must frequently have observed numerous black spots, each about half an inch in diameter. In some parts of the country hardly a leaf of this tree can be seen in autumn which is not disfigured by their presence. While still fresh and green on the tree, the foliage appears as though it had been bespattered with ink, and even on the brown withered leaves after they have fallen the dark spots are highly conspicuous. These blotches are caused by a parasitic fungus, *Rhytisma acerinum*, the maple mould, one of the *Ascomycetes*, an order of somewhat higher organization than the *Uredines* described in Knowledge for November, 1896. Other species of *Rhytisma* grow on willows, on Andromeda, one of the heaths; and on the nettle. Saccardo, in his "Sylloge Fungorum," describes no less than sixty-three species, from various parts of the world, parasitic on rhododendrons, magnolias, cacti, pines, and

Fig. I.—The Maple Mould (*Rhytisma acerinum*).

other plants. The generic name, from a Greek word meaning to dye or stain, is singularly appropriate, for leaves attacked by the fungus are stained in a very striking manner indeed (*see* Fig. I.).

By scraping a discoloured portion of a leaf and mounting on a microscopic slide we readily discover among the *débris* little fan-like tufts of elongated tubular cells, which are seen to be of two kinds; some are simply blunt hairs or paraphyses, others are linear or club-shaped sacs—the asci—each of which contains eight small rounded bodies, the ascospores (*see* Fig. II. 1).

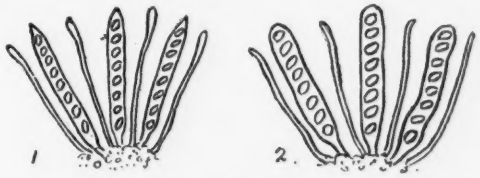


Fig. II.—Asci. 1. *Rhytisma*. 2. *Sphæria*.

A short search among grass during the winter months is sure to result in the discovery of numerous specimens with their leaves looking as if minute drops of tar had been sprinkled upon them. These black shining spots are not uncommon on the cock's-foot grass (*Dactylis glomerata*), and are caused by species of *Sphæria*, a genus closely allied to *Rhytisma*. Its asci are larger, and may be easily extracted by moistening an affected portion of the grass-blade and teasing it out on a glass slide. Each ascus, as in *Rhytisma*, contains eight ascospores (Fig. II. 2.)

The *Ascomycetes* are a very extensive order, including several of the larger fungi, such as the truffle, the morel, and the numerous *Peziza*, some of which possess an elegant cup-like shape, others being brilliantly adorned in orange and scarlet. Many grow on rotting wood; the little scarlet cushions of *Nectria cinnabarina*, so common on old sticks in every garden, must be familiar to many of our readers. Other *Ascomycetes* live among moss, on dead leaves, or on the ground, deriving their nourishment from the decaying organic matter in the soil. Some occur as moulds on fruit, bread, jelly, and the like; a few are developed in the bodies of living caterpillars; while a considerable number are parasitic on growing plants, and give rise to mildew and blight. The vine disease, which for some years wrought such havoc in the vineyards of France and Spain, is caused by *Erysiphe Tuckeri*; the hop blight by *Podosphæria castagnei*; the rose mildew by *P. pannosa*; another, *Claviceps purpurea* produces ergot on rye and other grains, rendering them unfit for food, and even poisonous. The lichens, those grey and orange incrustations so common on rocks and trees, should also be mentioned, since a lichen is simply an ascomycetous fungus which lives parasitically upon a number of unicellular algæ. Yeast is placed by some in this order, and De Bary is of opinion that the *Uredines* are a group of degraded *Ascomycetes*.

The spore sac or ascus is a structure characteristic of the whole series, and gives its name to the order. The subdivisions are distinguished by the nature of the sporocarp or body which bears the asci. The *Discomycetes* produce their asci on the surface of a flat or cup-shaped disc: the *Pyrenomycetes* develop theirs in the interior of flask-shaped receptacles or perithecia; while *Erysiphe* and *Tuber* are cleistocarpous, having their asci in closed sporocarps.

The wall of the sporocarp in many species consists of dense hardened cells, occasionally highly coloured, but more frequently brown or black. A vertical section through a grass blade with *Sphæria* on it shows a row of rounded perithecia sunk in the substance of the host, each invested with its black rind (Fig. III. 3). When mature the asci protrude through an opening at the top of the perithecium and eject their ascospores. The perithecia of

Rhytisma have also a carbonized rind, but they differ from those of *Sphæria* in forming a confluent mass which opens by flexuous fissures. The flattened sporocarps are closely applied to the upper surface of the sycamore leaf, and within the black rind is a mass of soft, thin-walled tissue, in the upper part of which, with the aid of the microscope, the asci may be distinguished (Fig. III. 1).

On a much larger scale we have in the truffle a body of essentially the same nature. Esteemed by epicures a vegetable delicacy, the truffle is the underground sporocarp

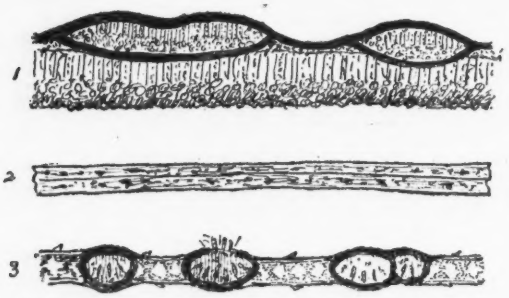


Fig. III.—1. Section of Sycamore Leaf, with Sporocarps of *Rhytisma*. 2. Grass Blade with *Sphæriæ*. 3. Section of Grass Blade with Sporocarps of *Sphæria*.

of an ascomycetous fungus. It has somewhat the appearance of a potato with a rough warted exterior. The solid substance inside shows marbled veins; under the microscope the white areas are seen to consist of ordinary mycelial tissue; the darker veins are masses of rounded asci, each enclosing two, four, or eight ascospores. In this country truffles rarely exceed three or four ounces, but in Italy and Germany they frequently attain a weight of several pounds. The people of those districts from which the principal supplies come employ pigs and specially trained dogs to guide them to the spots where the truffles lie buried, and in this way discover where to dig for them. The species of *Tuber* are fairly numerous (Fig. IV. 1).

If we imagine a minute truffle with its tubers flattened out into thin hollow plates, and these glued to the upper surface of the leaf, we have a fairly correct notion of the nature of the *Rhytisma* spots on the sycamore.

The sporocarps of *Sphæria* and *Rhytisma* grow directly from the mycelium; in other *Ascomycetes* the mycelium develops a hard, rounded, tuber-like sclerotium, containing reserve material, from which sporocarps are afterwards formed. Some part of the mycelium very generally assumes a sclerotioid and carbonized character as a preliminary to the formation of asci. Sclerotia may become detached and be dispersed: they usually remain dormant for a time; as little horny bodies they are frequent on the grains of grasses, rushes, and sedges; several kinds occur attached to the bodies of insects. Ergot grains are the sclerotia of *Claviceps;* in this case the sporocarps are not formed in the sclerotium, but from the latter there arise stalked club-like organs called stromata, and the perithecia containing asci are developed in the substance of the stroma (Fig. IV., 3 and 4).

The stroma forms the most conspicuous part of the fungus in the *Xylariæ*, common on old tree stumps; their erect branching stromata might be compared to little pieces of blackened coral. They are covered with a layer of cells bearing white gonidia, but when these are shed the carbonaceous rind beneath is exposed; it encloses softer tissue in which perithecia are formed. Each perithecium communicates with the exterior through a small opening in the rind; these openings have a lining of hairs which assist in discharging the ascospores. Much, then, as the little twig-like *Xylaria* (Fig. IV. 5), the truffle, and the wafer-like sporocarps of *Rhytisma* differ in external form, they are only different modifications of the same type of structure.

In those *Ascomycetes* which have been fully investigated, the sporocarp and asci are found to be the product of fertilization. The rose-blight fungus is one of the simplest; its web-like mycelium, which spreads over the leaves of its host, develops specialized cells, the antheridium and carpogonium, functionally equivalent to the stamens and pistils of flowering plants. After fertilization the carpogonium divides into two cells, one of which becomes an ascus with eight ascospores. From a cell beneath it filaments arise, which closely invest the ascus and constitute the wall of the little spherical sporocarp. The development of *Erysiphe* is very similar; the carpogonium is more highly differentiated in the bread mould *Eurotium*, and in *Peziza* it is provided with an additional style-like organ, the trichogyne, to which the antheridium is applied in fertilization. The common cheese mould is a small truffle; its minute sporocarps, no larger than grains of sand, result from a process of fertilization similar to that of *Erysiphe* and *Eurotium*. The formation of asci appears to depend on sexual reproduction, and though not yet proved in every case the view is commonly held by mycologists that fertilization is universal among the *Ascomycetes*.

The sporocarps of certain species are extremely rare, the fruits of some being quite unknown. The *Erysiphe* of the grape vine, notwithstanding its wide diffusion over Southern Europe, has never been known to produce a sporocarp. Its propagation is effected entirely by gonidia, as those reproductive cells are termed which do not result from fertilization, but are formed by simple vegetative division. On most species both sporocarps and gonidia occur, but the latter are usually much more abundant. A mildew (*Erysiphe graminis*) forms little white flocculent tufts, very common on the blades of many grasses in autumn; these are made up of strings of egg-shaped gonidia (Fig. V. 1). Another species attacks fruit trees. A pear tree we examined looked as though it had been all powdered over with chalk. On submitting a portion of a leaf to the microscope, there was seen projecting from the epidermis a perfect forest of crystalline gonidia chains, as beautiful a microscopic object as one could wish. Yeast has some claim to be regarded as the gonidial condition of

Fig. IV.—1. Truffle. 2. Its Ascus. 3. Ergot—*sc.* Sclerotium, *st.* Stroma. 4. Section of Stroma, showing Perithecia. 5. *Xylaria*.

an *Ascomycete*. Ordinarily it is propagated in saccharine solutions by budding, but if nutriment be deficient, as when it is grown on a slab of plaster of Paris, many of the cells assume the appearance of asci, each producing four spores in its interior. Gonidia are of various forms; the same mycelium may bear two or three different kinds, as in the *Uredines*, where the teluto and uredospores are non-sexual spores or gonidia. In the common moulds *Eurotium* and *Penicillium*, the gonidia chains are formed in clusters at the top of a slender stalk, giving the fructi-

fication some resemblance to a mop or brush (Fig. V. 2). Sometimes the gonidia are produced in receptacles resembling perithecia; these pycnidia in some cases can hardly be distinguished from spermogonia, such as we find in lichens and associated with the cluster-cups or the *Uredines*. Pycnospores germinate more freely, however, than spermatia. *Cucurbitaria* growing on laburnum bark has four different kinds of pycnidia, but these organs sometimes appear on a mycelium to which they do not properly belong. On *Erysiphe* pycnidia occur belonging to *Cicinnobolus*, the slender mycelial threads of which traverse the thicker ones of *Erysiphe*. Nor are such cases uncommon where one fungus preys upon another which is itself parasitic. *Peziza rhytisma*, as its name indicates, selects the spots of the maple mould as its peculiar habitat. The well-known lines of Swift apply to the vegetable as well as to the animal kingdom :—

> "So, naturalists observe, a flea
> Has smaller fleas that on him prey;
> And these have smaller still to bite 'em,
> And so proceed *ad infinitum*."

Another *Ascomycete* which attacks the leaves of maples is *Uncinula bicornis;* its sporocarps are minute dark-coloured spherical bodies, but *Melasmia acerinum* is not a distinct fungus—its supposed pycnidia are really the spermogonia of *Rhytisma*. In this instance what is truly a part of the plant itself was long mistaken for a parasite.

The mechanism for the discharge and scattering of the spores in many of these microfungi is very curious, and

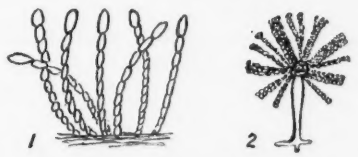


Fig. V.—Gonidia. 1. Grass Mould (*Erysiphe graminis*). 2. Blue Mould (*Eurotium aspergillus glaucus*).

quite equal in interest to the contrivances by which the dispersion of seeds is effected in flowering plants. In *Sphæria* the cell-membrane of the spore sac is highly extensile; each ascus as it ripens suddenly stretches itself up half way through the opening of the perithecium, and from its apex discharges the ascospores swiftly one by one like so many arrows. Similar lively proceedings may be observed in *Ascobolus*. The ripe gonidia of *Pilobolus*, *Coprinus*, and others are thrown off by the explosion of a subjacent cell. The stalks of the spores in other instances are twisted, and so hygroscopic that the slightest change in the humidity of the air produces such rapid torsion that the gonidia at their extremities are twirled away. *Rhytisma*, in common with many *Peziza*, exhibits the phenomenon of puffing, which consists in the emission of a little cloud of spores in consequence of many asci discharging their contents simultaneously. The spores of some *Sphæriæ* have a gelatinous appendage; those of *Rhytisma andromeda* are coated with viscid matter, provisions enabling them to adhere readily to their hosts. *Rhytisma* produces its asci in spring; there are many points in its life history which still require investigation.

Science Notes.

By courtesy of the Royal Geographical Society, we are enabled in the accompanying illustration to give an exact reproduction of the gold medal which the Society struck for Dr. Nansen. The medal was presented to Dr. Nansen by H.R.H. the Prince of Wales, at the great meeting in the Albert Hall, on the 8th of February, 1897. On the same occasion a silver replica of the medal was handed to Lieut. Scott Hansen, and similar replicas were afterwards sent to Captain Sverdrup, Lieut. Johansen, and

Obverse.

Dr. Blessing. The eight other members of the expedition received bronze replicas of the medal. Upon a riband in the upper part of the medal is the word "Fram," the Norwegian for "Forward," and used here as a motto. The Financial Committee of the Norwegian Storthing has

Reverse.

unanimously adopted a proposal in favour of granting four thousand kronor to each of Dr. Nansen's twelve companions, and three thousand kronor yearly during a period of five years to Captain Sverdrup, who will be at the head of the next expedition in the *Fram* planned by Dr. Nansen for 1898. No Parliamentary grant is demanded for the expenses of this new expedition. Lecturers will be pleased to hear that the lantern slides used by Dr. Nansen at his lectures can now be obtained of Messrs. Newton & Co., who made them for Dr. Nansen. The distinguished explorer has been appointed Professor of Zoology at Christiania University, and has also received honorary degrees in this country.

Dr. T. K. Rose, in *Nature*, March 11th, describes the methods of gold extraction by the wet process. Although rapid advances have been made in the science of chemistry, only about one-tenth of the total output of gold is produced by that means. The chief processes of wet extraction are by means of mercury, chlorine, and cyanide of potassium. The mercury process is very imperfect, owing to minute particles of gold remaining undissolved, and also because of the action of mercury on sulphides of iron, antimony, and arsenic, which are hardly ever absent from gold ores. The chlorination process is more satisfactory, but is rather expensive. When sulphides are present, preliminary roasting is necessary. In some cases chlorine gas is employed, but nowadays strong aqueous solutions of the gas are found to act more rapidly. The disadvantage of this process is assignable to the preliminary roasting of the ore. The best process of all is the MacArthur and Forrest cyanide method, which obviates preliminary roasting of the ore. This method of extraction is based on the solubility of gold in potassium cyanide, and the subsequent separation of the gold by means of zinc. Sulman and Teed propose to add cyanogen bromide to the potassium cyanide, but this method has not been carried out on a large scale up to the present. Siemens and Hulske propose to precipitate the gold from cyanide solutions by electro-deposition, but this method is costly, because of the large amounts of iron and lead consumed.

Mr. W. Eagle Clarke, M.B.O.U., sends us an account of the occurrence of the frigate petrel (*Pelagodroma marina*) on the west side of Scotland. The bird, a female, was captured alive on 1st January of this year, by the margin of a stream on the west side of the Island of Colonsay. Having been forwarded in the flesh to Edinburgh and identified by Mr. Clarke, it is now in the Scottish National Collection, in the Museum of Science and Art in that city. The closing week of December last was remarkable for a succession of south-westerly gales. This is the second recorded occurrence of this petrel in European seas; and it is interesting to note that the first record was also for the west coast of Britain, namely, at Walney Island, in Morecambe Bay, where a specimen was washed ashore dead in November, 1890. The frigate petrel has a wide range in the southern hemisphere, and it was found breeding in great numbers on the islands off South-Western Australia by Gould's collector, Gilbert. Prior to November, 1890, the most northerly point reached by this species was the Canary Isles, where it has been identified on several occasions.

At a recent meeting of the Royal Botanic Society, the Rev. Prof. Henslow read a paper upon the effects of light on the colouring of plants, a subject on which very little is known. He spoke of the work lately done by Mr. Sorby in this direction with the spectroscope, explaining the effects of the different light-rays upon plant colours, and showed how all colours were really produced in the green tissue of the leaf. It appears that the learned professor agrees with the theory that yellow is the primary colour.

Ripples produced on a mercury surface, according to Mr. J. H. Vincent, are invisible to the unaided eye; but by means of an electric spark photographs of ripples set up in the mercury by a stylus attached to a tuning-fork can be obtained. The phenomena of interference, diffraction, etc., can thus be shown in quite a novel way.

THE AGE OF MOUNTAINS.—II.

BRITISH MOUNTAINS.

By Professor J. Logan Lobley, F.G.S.

THE mountains of the British Islands, though their highest summits are but of very moderate elevation when compared with the principal mountain ranges of the globe, are yet of great geological and physiographic interest. Rising, too, sometimes abruptly and steeply from little above the level of the sea, they show their full height, and so give bold and very varied, and in many cases exceedingly beautiful, scenery. Their chief interest, however, lies in the fact that they include perhaps the oldest mountain lands of the world.

They are very distinctly grouped, each group occupying a well-separated area, and the geology also of each group is, in the main, distinct. Thus the study of British mountains and hills may be simplified by considering them in groups, which may be arranged and designated as follows:—

England: Cumbrian, Pennines, Western, Mendips, Ocryneans, Central, South-Eastern.

Wales: North-Western, Central, Southern.

Scotland: North-Western, Grampians, Southern.

Ireland and the Isle of Man: South-Western, South-Eastern, North-Eastern, North-Western, Manx.

Though space will not allow of the geology of each of these groups being more than very briefly summarized, yet this will, it is hoped, clearly show the very interesting character of the geology of British mountains.

ENGLAND.

The mountains of Cumberland, extending into North Lancashire and Westmoreland, constituting the beautiful English Lake District, demand, from their height and the importance of the area they form, first attention. The group attains in Scafell Pike an elevation of three thousand two hundred and twenty-nine feet above the level of the sea. This highest mass, with its surrounding mountains and the peaks and ridges to the east, consists mainly of volcanic rocks, the accumulated ejectamenta of a great volcano possibly as large as Ætna. At Castle Head, close to Keswick, may be seen a mass of Igneous rock that may be the root of the infilling of one of the vents of this great mountain, which existed and was active as a volcano in Lower Silurian times; and its ruins, which now constitute these mountains, may consequently be assigned to that period. On the western side, and on the extreme east of the area, are vast masses of newer, because intrusive, Plutonic granites and syenites. From the great hardness, but still varying hardness, of these Igneous rocks, rugged and precipitous features characterize the area, and give the wildest and most picturesque scenery of the Lake District. The mountains to the north are largely composed of highly metamorphosed Cambrian and Lower Silurian rocks, the *débris* of very ancient lands, to which the name Skiddaw Slates is given. The volcanic rocks rest against them, and these again are covered in places, or over-stepped, by the Coniston Limestone series of Bala (Lower Silurian) age. Above the Coniston Limestones, in the south-eastern corner of the district, are Upper Silurian rocks at a high level. Although the Skiddaw Slates were elevated before the volcanic series were accumulated, and therefore in Lower Silurian times, a subsequent depression and still later re-elevation gives to these mountains, including Skiddaw and Saddleback, a date which may be fixed as being between Upper Silurian and Carboniferous times, by the fact tha

Carboniferous rocks overlie the Upper Silurians unconformably, and at a much lower angle.

The Pennine mountains of England, with which may be associated the Cheviots on the Scottish border, extend from the northern boundary of England to Derbyshire (summit elevation, Cross Fell, two thousand eight hundred and ninety-two feet), and are formed of Carboniferous or Mountain Limestone, Yoredale rocks, and Millstone Grit; but of Igneous rocks there is an immense mass in the Cheviots, and in Derbyshire the "Toadstone" makes its appearance amidst the Carboniferous Limestone. The whole range forms a great anticlinal with the Millstone Grit, dipping both on the east and on the west under the Coal Measures of the lower levels on either side. The age of the Pennine range must therefore be later than the Carboniferous period, but earlier than the Triassic, the rocks of which epoch extend on each side approximately horizontally.

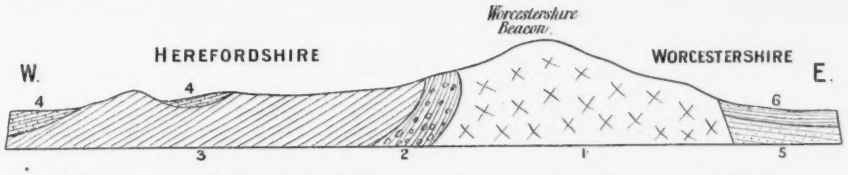
The western elevations of England are very ancient lands. The most southern of these, the Malverns (Worcestershire Beacon, one thousand four hundred and forty-four feet), which form a very perfect mountain range on a small scale, have a central ridge with expanding base of Syenite, a varying rock largely made up of felspar and hornblende. Elevation took place here in very early times, as the Hollybush Sandstone of Cambrian age lies quite unconformably on the upturned edges of the crystalline Silurian rocks. Silurian rocks are also high on the flanks of the Malverns, with a high dip; and so it is evident that although there may have been a pre-Cambrian ridge, a subsequent depression took place which extended through the Devonian period. But on the eastern side of the Malvern range Triassic rocks abut at a low angle against the Syenite, and extend to the east almost horizontally; while a "fault" with a remarkably great "throw" extends north and south for many miles, dividing the low lands of the Severn Valley from the uplands of the west.

A little to the north, in Shropshire, the remarkable Caer Caradoc, Corndon, the Clee Hills, and the Wrekin, that stand out very conspicuously, and are due to being altogether or in part formed of hard Igneous rock that has resisted denudation. In the case of the Clee Hills, a sheet of basaltic rock forms the summit, and through this shafts are sunk to work the coal of the underlying Coal Measures.

The Mendips are a very interesting group of elevations that illustrate rock-folding on a grand scale, and subsequent to Carboniferous times. The mass consists of Old Red Sandstone and Carboniferous Limestone, both greatly folded and so presenting strata at a high angle of inclination. That the elevation giving this dip was pre-Triassic is shown by the fact that rocks of Triassic age lie so unconformably that they are approximately horizontal on the highly inclined Carboniferous rocks.

The Ocrynean hills of Devonshire and Cornwall (Yes Tor, two thousand and fifty feet) are largely formed of the granites that are so conspicuously seen in the tors of Dartmoor and some Cornish localities. That these granitic masses took their present relative position to the neighbouring sedimentary rocks after the formation of those rocks is shown by the adjacent uptilting and metamorphosation. A study of rocks enwrapping the granitic masses places the age of the uprise as post-Devonian.

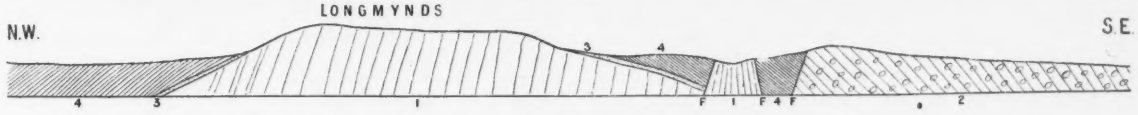
Leaving the mountains and hills of the North, the West, and the South-West of England, and coming to the central area, it will be found that the elevations there consist chiefly of much newer formed land than the elevated areas hitherto considered. But there is a notable exception. The hilly district constituting Charnwood Forest, in Leicestershire, is formed of rocks that are so ancient that it has been a most difficult problem to determine their age. They were once thought to be Igneous, so extreme has been their metamorphosation; but they are now determined to be altered sedimentary rocks, by some thought to be pre-Cambrian, and by others Cambrian. An elevation, however, certainly took place



Section across the Malverns. 1. Malvern Rock (Syenite, etc.). 2. Caradoc. 3. Wenlock. 4. Old Red Sandstone. 5. Bunter. 6. Keuper.

Longmynd Hills (summit, one thousand six hundred and seventy-four feet), consisting of the oldest Cambrian rocks in a nearly vertical position, with Upper Silurian beds lying on their truncated edges, form classic ground for geologists. The verticality of the strata, estimated at twenty-five thousand feet in thickness, and its truncation, denotes great elevation, with folding and subsequent denudation on an enormous scale, and, later, a depression to allow of the deposition of Upper Silurian rocks. But as these latest formed rocks are at a high level it will be necessary to fix the age of the Longmynds as post-Silurian. The western district of England is diversified by some bold hills, as before the Carboniferous period, and another before the deposition of the Triassic rocks that lie all around the area, almost horizontally. At a little distance to the east is the remarkable mass of rose-coloured hornblendic granite forming Mount Sorrell, also in its elevation pre-Triassic. The central hills of England are, however, chiefly of Secondary geological age, and therefore form much newer land than that of any of the areas hitherto considered.

The Chalk hills forming the south-eastern elevations of England have certainly been elevated since the Eocene period, for they carry on their surface many Eocene



Section across the Longmynds, Shropshire. 1. Cambrian. 2. Caradoc or Bala. 3. Upper Llandovery. 4. Wenlock Series. F. Faults.

"outliers." Thus the Marlborough Downs, the Chiltern Hills, the North and the South Downs, and the chalk hills forming the backbone of the Isle of Wight, are all of post-Eocene age. The last-named, at Whitecliff Bay and at the Needles, may be seen to be almost vertical, with the whole of the Lower Eocenes sharing their high angle of inclination.

WALES.

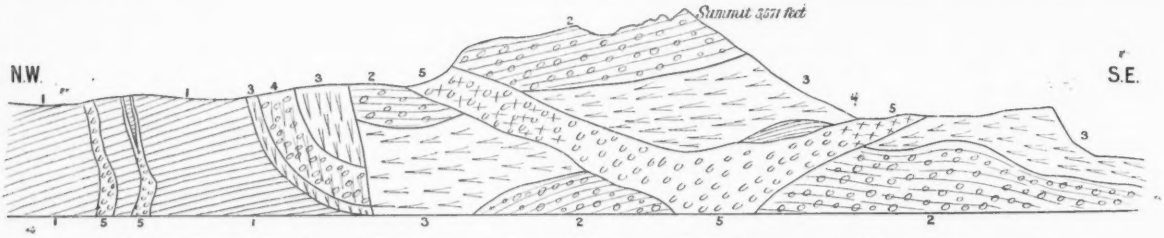
The Snowdonian mountains (Snowdon, three thousand five hundred and seventy-one feet) have at their loftiest summit rocks of Bala or Lower Silurian age, and they are there the remains of a vast synclinal fold the greater portion of which has been removed by denudation; so that possibly no less than ten thousand feet thickness of rocks have been destroyed that were above what is now the summit of the king of the Cambrian mountains. Associated and interbedded with these sedimentary rocks are great sheets—or, rather, masses—of Igneous rocks, which, together with the Bala rocks, have been upheaved to great heights above their original level, and so are unlike the volcanic Cumbrian masses, which have been accumulated at an original high elevation. The lower beds of the Llandovery rocks, abutting on and resting unconformably on the Snowdonian rocks, are conglomerates, and so show shallow water conditions, from which it may be concluded that the elevation of the mass was towards the close of the Lower Silurian period. Many changes of level have doubtless occurred since; and there is evidence in the shells of recent age on Moel Tryfan, at an elevation of one thousand three hundred feet, that the whole of Snowdonia below that level has been below the sea-level in Pleistocene or Quaternary times.

south-west conformably by the Carboniferous rocks. The age of the elevation must therefore be post-Carboniferous.

SCOTLAND.

In Scotland the north-western mountains (Scour Ouran, three thousand and five feet) are separated from the more central Grampians by Gen More, or the Great Glen, extending across Scotland in a south-east to north-west direction, from Loch Linnhe to the Moray Firth, at Inverness. These mountains possess very great geological interest, from displaying the oldest rocks in the British Islands. They consist of crystalline schists, gneiss, quartzites, and various granites, all highly metamorphosed rocks that have been elevated, folded, contorted, and penetrated by Igneous rocks before the overlying strata were deposited. These are red and purple sandstones (Torridon Sandstone) of Cambrian age, which rise to considerable elevations, and dip to the east. They are overlaid in turn, and unconformably, by a series of Calcareous rocks, some dolomitic. These rocks are known to be of Lower Silurian age, and to the east pass under the Old Red Sandstone. Conglomerates in the Lower Old Red contain not only pebbles of the older rocks, but fragments of considerable size, and even large masses. The elevation of these mountains must therefore be determined to be consequent upon several movements at widely separated periods: firstly pre-Cambrian, then pre-Bala, and then pre-Devonian. A very remarkable feature of these mountains is a most extensive overthrust, whereby the older rocks have been made to overlie the Silurians. This renders the geology here very complicated and difficult.

The central mountains of Scotland, called the Grampians, lie between the Great Glen and the valley extending across



Section through Snowdon. 1. Llandeilo. 2. Caradoc or Bala. 3. Felspathic Trap. 4. Volcanic Conglomerate. 5. Intrusive Igneous Rocks.

The mountains of Central Wales are apparently so confused that they, to an ordinary observer, seem to be incapable of arrangement even physiographically. They have, however, been interpreted chiefly through the early work of Sedgwick and Murchison. They consist of Silurian rocks flanked on their north-western side by Carboniferous rocks, and the Silurians in Merionethshire form a great anticlinal which is the complement of the Snowdonian synclinal. Associated with the Silurian rocks, especially with the Llandeilo, are vast interbedded masses of volcanic rocks and traps, which, forming very steep ascents and perpendicular precipices, give a rugged and wild aspect to the scenery comparable with the volcanic area of Cumberland. As the Carboniferous Limestone on the west in Denbighshire and Flintshire rises to a very considerable elevation, it must have shared in the general elevation, and so the central mountains of Wales may be considered to be post-Carboniferous and pre-Triassic.

The southern mountains of Wales include the Black Mountains with the Fans of Brecon (summit elevation, two thousand eight hundred and sixty-two feet). They are formed of the Old Red Sandstone, which here has a thickness of fully ten thousand feet, and is covered on the

the island from the Firth of Forth to the Firth of Clyde. Although these are formed in the main of highly altered Lower Silurian rocks also, they have several features in which they differ from the more northern mountains. The intrusive Igneous rocks are much more important, forming as they do vast masses that tower to great elevations, and form important mountain summits; one of these is the highest land in the British Islands, Ben Nevis (four thousand four hundred and seven feet). Denudation has sculptured the whole mass into more varied contours, which give more rugged scenery. This sculpturing has, however, been commenced on a tableland, as is apparent when an extensive distant view is obtained of these mountains, for then it is seen that the summits rise to a straight line with remarkable uniformity. Again, the watershed is not so near the sea on the west, though still much nearer than to the east coast. Old Red Sandstone, with basal beds of coarse conglomerate, lies unconformably on the Silurians to the east, from which we may place the period of the great uplift before the deposition of those rocks.

The southern mountains of Scotland (Mount Merrick, two thousand seven hundred and sixty-four feet) are likewise

formed of Silurian rocks, with a large amount of intrusive Igneous masses; but the rocks are for the most part not metamorphosed like their representatives of the Grampians, and so give smoother features with grassy hill-slopes. The Igneous rocks have in many places been outpoured as lava over the sedimentary strata, and resisting denudation by their superior hardness now form hilltops, and so preserve the softer rocks below. The Silurian strata dip northwards under the Old Red Sandstone and Carboniferous rocks, to reappear in the Grampians highly metamorphosed. As the Carboniferous beds have once extended over the whole area from the Lanarkshire coal-field to the Cheviots, the elevation of Scotland's southern mountains must have been subsequent to the Carboniferous period.

IRELAND AND THE ISLE OF MAN.

When St. George's Channel is crossed other most interesting groups of mountains present themselves in Ireland. These surround the great central plain of the island of Carboniferous Limestone.

The highest mountains of Ireland are in the south-western group, where in the Killarney district one of the peaks of Macgillicuddy's Reeks, Carntual, towers to three thousand four hundred and fourteen feet above sea-level. This portion of Ireland is formed by Devonian and Carboniferous rocks in a succession of parallel anticlinal and synclinal folds, the Devonians forming the anticlinals, which are elevations that to the west project into the sea and form the bold and picturesque headlands of the South-West of Ireland, while the Carboniferous rocks in narrower bands occupy the synclinal valleys which terminate seawards in bays and indentations of the coast. As there are no remains of later strata here it is necessary to look to the eastward prolongation of these flexures in England in determining the age of the upheavals, and there it is found that horizontal Triassic rocks rest upon highly inclined Carboniferous strata, which indicates an elevation of the south-western mountains of Ireland between the Carboniferous and the Triassic periods.

In the South-East of Ireland a group of mountains rises, in Lugnaquilla, to three thousand and thirty-nine feet, and consists of ranges having a south-west and north-east general direction. They are formed of Cambrian and Lower Silurian rocks, with great masses of intrusive granites and intrusive Igneous rocks. The granites form a great mountain mass extending south-westwards from Dublin Bay, and are possibly mainly metamorphic. They are, however, confined to the Silurian area. As the Old Red Sandstone has been found to overlie the Silurian rocks, and then eroded granite—which, from its importance in the area, must be associated with the general upheaval—it may be concluded that this upheaval was pre-Devonian, but subsequent to, or at the close of, the Lower Silurian period.

Passing to the north, there is a remarkable group of mountains, which give a summit elevation in Slieve Donard of two thousand seven hundred and ninety-six feet. These mountains form three ranges, the Mourne, the Carlingford, and the Slieve Croob Mountains, of which the first is the highest. They consist chiefly of metamorphosed and Igneous rocks, granites, syenites, dolerites, etc., and may be regarded as portions of the base of a great volcano. From their containing altered Carboniferous Limestone masses, the age of the rocks is certainly post-Carboniferous; and from their dissimilarity to the Tertiary volcanic rocks of Antrim, they are probably much older than the Tertiary period.

The north-western mountains of Ireland, with which may be associated those in the extreme west, are undoubtedly the oldest mountains of the island. They rise to a summit elevation, in Muilrea, of two thousand six hundred and thirty-eight feet above the level of the sea. They consist of metamorphosed and highly contorted Lower Silurian rocks, with Upper Silurian strata unconformable and unaltered, and containing beds of conglomerates; and in Donegal, as before mentioned, a great granitic mass ranges from south-west to north-east. The stratigraphical evidence indicates an upheaval here at the commencement of Upper Silurian times.

The mountains of the Isle of Man are very lofty elevations for the size of the island, attaining in Snafell to two thousand and thirty-four feet above the level of the sea. They are formed of schistose rocks of the same character and age as the Skiddaw Slates of Cumberland, which encircle and overlie masses of granites. These Lower Silurian rocks are upturned, and on their denuded edges repose conglomerates which have now been determined to be the lowermost beds of the Carboniferous series, though once thought to be of Devonian age. The elevation of the mountains, it is therefore evident, had taken place before the Carboniferous rocks were deposited.

Notices of Books.

The Life and Work of Charles Pritchard, Savilian Professor of Astronomy in the University of Oxford. (Seeley.) 10s. 6d. Many hands have contributed to the portraiture in this work, and it was a wise arrangement, for Prof. Pritchard's life was a long one, and of such varied activity that a single biographer could scarcely have done justice to its very different aspects. "He really lived the lives and earned the fame of two or three ordinary men." The book has been in part written by Miss Ada Pritchard, and she has entrusted the first chapter on his early life to Prof. Pritchard's niece, Mrs. Ogier Ward, and the little details which the latter gives of his ancestry and early upbringing afford a clue to much that otherwise would be incomprehensible in his character. It enables us to understand how a man "bristling at all points with asperities" could yet not only win general respect, but exercise a positive fascination. It is, perhaps, as a schoolmaster that Pritchard was seen at his best. His originality and keen discernment showed here to the greatest advantage, and he became not merely one of the pioneers of modern education, but apprehended and avoided educational pitfalls which are even yet too common. In this section the editor has wisely allowed her father for the most part to speak for himself, the second chapter being drawn from his autobiographical pamphlet, "Annals of our School Life." Here he lays it down as a maxim "that the main intention of early education should be the development of the *habit of thinking*, and the exhibition of the right mode of setting about it."

His second great rule was, that the time for the multifarious instruction required for his full scheme of education was to be found "in the systematic accumulation of small increments: but it must be systematic, and, beyond all, it must be sincere and impartial." It was the same principle of steady and systematic accumulation which enabled him when director of the University Observatory at Oxford to accomplish in the last years of his life more than many men have done in a whole lifetime of spasmodic devotion to the science. Thus the completion of more than seventy thousand careful measures of photographs of stars, he says, might be accomplished by equal daily instalments, without any stress of mind, in less than a year.

His successor at Oxford, Prof. Turner, emphasizes Prof.

XUM

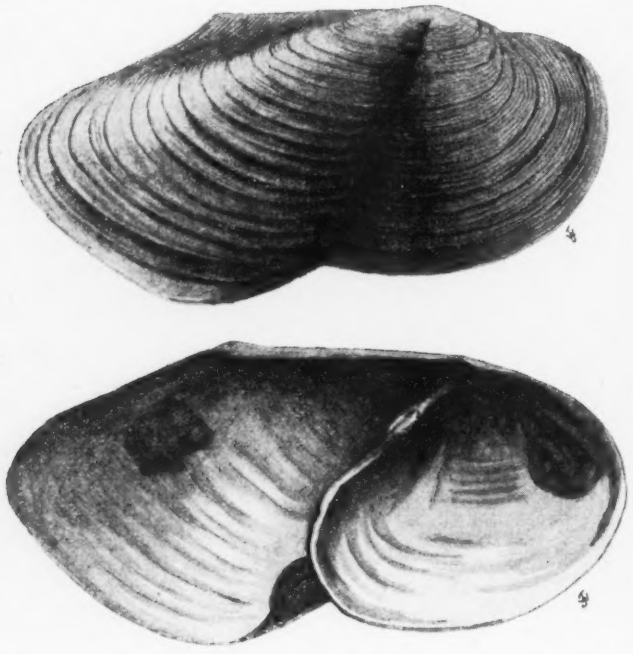
Pritchard's method in his astronomical work; for it was a point with the latter to take up a definite research and then carry it to a distinct completion, "leaving no straggling ends to be gathered together after his death."

His career as a schoolmaster, first at Stockwell Grammar School, then at Clapham, occupied nearly thirty years, from 1833 to 1862. The eight following years, the story of which is told by his daughter, Miss Rosalind Pritchard, were spent at Freshwater. This was the time in which he served the Royal Astronomical Society in the successive important offices of Secretary, Vice-President, and President. With his removal to Oxford in 1870 he entered on an entirely new career—depicted to us from the point of view of his family by Miss Ada Pritchard, from that of his profession by his successor Prof. Turner; whilst the Bishop of Worcester, as an old and intimate friend, deals with his theological work.

That the life of a man so original and many-sided should have been entrusted not to one writer but to several, each dealing with that phase for which they were best equipped, and yet all combined in one harmonious whole, renders the book a vivid—one might say a stereoscopic—representation of its subject, and frees it from that bane of biography—monotony.

And the book will be valuable not merely as a portrait or from its quick interest. Prof. Pritchard's example, his earnestness, sincerity, and method, may well inspire many a worker, and teach to others the joy he felt himself: "We are never so happy as when we have a little too much to do, and do it."

The Collector's Manual of British Land and Freshwater Shells. Second Edition. By L. E. Adams, B.A. (Taylor Bros., Leeds.) Illustrated. *A Monograph of the Land and Freshwater Mollusca of the British Isles.* By J. W. Taylor, F.L.S. (Taylor Bros., Leeds.) In three parts. 6s. each. It would have been matter for regret had not this "Collector's Manual," with its well-pourtrayed figures and valuable original observations, met with due appreciation by those interested in the freshwater mollusca. The author has a true perception of the spirit of scientific research, which is significantly displayed in the generalizations drawn from the many years' systematic examination of specimens gathered from every part of the island, the total result forming a valuable acquisition for the conchologist. The discrimination exhibited in the compilation of the elaborate synoptical tables is beyond praise, and this part of the work may be recommended to the notice of beginners as being specially useful in comparing new finds. The "Monograph of the Land and Freshwater Mollusca," by Mr. Taylor, brings together, as far as practicable, all reliable information bearing upon the study of this subject, not from the specialist's point of view, but in a way which aims at combining all the many aspects of this department of knowledge. An excellent coloured frontispiece accompanies each part, and there are hundreds of other illustrations of the very highest character as regards artistic effect. The descriptive part is clear, comprehensive, and accurate, and, best of all, bristles with original observations which entirely eliminate the dry-as-dust element often associated with such works. A curious monstrosity or malformation is here reproduced which will convey some idea of the quality of the illustrations.



Anodonta cygnea (L.), Sandwill Park, Staffordshire, collected by Mr. J. Madison, showing the effects of some severe laceration of the mantle, the result of which is seen in the strongly separated parts of the left valve and in the deeply-furrowed right valve. From "A Monograph of the Land and Freshwater Mollusca of the British Isles."

Miscellaneous Papers. By the late Prof. Heinrich Hertz. With an Introduction by Prof. Philipp Lenard. Authorized English Translation by D. E. Jones, B.Sc., and G. A. Schott, B.A., B.Sc. Pp. 340. (Macmillan.) 10s.

It is impossible to do justice to the contents of this volume in the brief space of a review. We cannot even refer to all of the twenty-two papers it contains, much less set forth their scope and teaching. Most of the papers describe the earlier investigations which Hertz carried out before his great electrical researches. At the age of twenty-one he began his first independent research at Berlin, while a pupil of Von Helmholtz and Kirchoff. The subject—electric inertia—offered difficulties which many experienced investigators had been reluctant to attack, while, at the same time, only a negative result could be anticipated. But Hertz finished the task, and was able by his experiments on the magnitude of the extra current to assign an upper limit to the kinetic energy of electricity in motion. His next paper was more theoretical, but, nevertheless, was of extreme value, and it is so rare that physicists will be glad to find a translation of it in the present volume. The subject is "Induction in Rotating Spheres." The currents induced in moving masses of metal by magnets had been studied by Arago, Faraday, and others, and Maxwell had worked out the theory of the currents induced in a thin plate, showing also how it could be applied to Arago's disc. But it was left to Hertz to solve the problem of the case of a solid or hollow sphere rotating about a diameter, when the inducing magnets were outside, or, in the latter case, inside, the sphere.

In 1882 Hertz began his investigations of the electric discharge in gases, and before a month had passed he discovered a curious characteristic of the spark discharge. Then came his paper on the cathode rays, for the study of which he fitted up a battery of one thousand secondary cells. To the majority of people the cathode rays are but things of yesterday, and even to many men of science the fact that Hertz arrived at the following conclusion will

come as a revelation. He said: "We are forced by the phenomena to assume that there are different kinds of cathode rays, whose properties merge into one another and correspond to the colours of light. They differ among themselves in respect of exciting phosphorescence, of being absorbed, and of being deflected by a magnet." This was written in 1883, yet only last year the composite character of the cathode rays was announced as a new discovery!

It was Hertz's observations on the passage of cathode rays through thin layers of metal placed in vacuum tubes that led to Lenard's work with tubes having an aluminium window, through which the rays could pass to the outside, and afterwards resulted in Röntgen's discovery. This paper of Hertz's was published in 1892, and is included in the present volume.

There are a few other papers which must be mentioned. One deals with the relations between light and electricity, and in it Hertz explains the evidence that light of every kind is an electrical phenomenon; then there is a paper in which a scientific definition of hardness is arrived at, several papers on elasticity, and a paper on the evaporation of liquids in vacuo; and introducing these masterly productions is Prof. Lenard's sketch of Hertz's scientific development.

We have exceeded the limits within which this review ought to have been curtailed, having regard to the number of other works calling for notice in these columns; but a Hertz does not often arise, and we could not in justice say less of the brilliant contributions to science contained in the book before us. The volume commands a place in the library of every institution and individual interested in physical research. It is a monument to a scientific genius, and as an example of good translation it will be difficult to excel. For the addition of the work to British scientific literature, physicists cannot be too grateful.

A Geographical History of Mammals. By R. Lydekker, B.A., F.R.S. (Cambridge University Press.) Illustrated. The geographical distribution of animals is always an interesting and instructive subject. Mr. Lydekker's volume

Head of Male Mule-Deer (*Cariacus macrotis*).
From "A Geographical History of Mammals."

differs from others on the same subject in several ways. The distribution of fossil forms has received greater attention, the volume deals with mammals only, and needless to say the zoogeographical regions differ from those of other works. It will be indeed a time of rejoicing when all zoologists decide to adopt one system of dividing the earth into zoological divisions. As the case stands at present, one cannot refer to two books on the subject which adopt the same regions or even the same names for the regions. The general plan of Mr. Lydekker's book is, after an introductory chapter, to give a detailed account of each of the regions and its sub-regions. Thus, after the extent and characters of the region are described, an account is given of the animals inhabiting it, how they probably arrived, and how they differ from or resemble the animals of other regions; the palæontology of the region is then treated of at some length. The book is undoubtedly a good one for the student, although we are inclined to think that the author has, like a good host, offered more than enough to satiate the most ambitious.

SHORT NOTICES.

List of Private Libraries. Vol. I.—The United States and Canada. (Leipzig: G. Hedeler.) This is the first volume of an interesting project for bringing together brief descriptions of the more important private collections of books, manuscripts, autographs, prints, portraits, etc, as well as fine bindings. This volume deals with the United States and Canada, and is intended to be followed by one dealing with Great Britain. The owners' names appear in alphabetical order, and the description is set out in English, French, and German, side by side. This alphabetical list is followed by an index to towns, and also a subject index.

The Earth and its Story: a First Book of Geology. By Angelo Heilprin. (Boston: Silver, Burdett, & Co. London: Gay & Bird) 5s. Illustrated. Admirably conceived, clearly and lucidly written, with a good index, and sixty-four most informing illustrations, this is an excellent popular manual on the story of the ages. The author claims for his illustrations that they are mainly reproductions from photographs taken in the field, and they certainly form most interesting accompaniments to the text.

The Literature of Music. By James E. Matthew. (Elliot Stock.) This is a new volume of the favourite Book-Lovers' Library, and the author is avowedly an enthusiast in his subject. The attempt to cover so much ground in so limited a space has rendered the task a difficult one, and if the result is rather a catalogue than a narration it is largely due to the exigencies of space. Much valuable information on the literature of ancient and modern music and musical instruments, together with its histories, dictionaries, and bibliography, is brought together, the whole being supplemented by an index.

Greenwood's Library Year Book. Edited by Thomas Greenwood. (Cassell & Co.) This excellent annual presents a lucid record of goodly work, and Mr. Greenwood is to be congratulated upon the phenomenal success which has attended his efforts in the public library movement.

The Art of Projection and Complete Magic Lantern Manual. By an Expert. (E. A. Beckett, 111, Kingsland Road, N.E.) Illustrated. 3s. 6d. To those who need assistance in the management of the lantern, and reliable information respecting the many accessory pieces of apparatus used in conjunction therewith, we can recommend this book. It is profusely illustrated with figures that plainly indicate the correct methods for obtaining desired results, tables of ready reference for showing the relations between lantern and disc with object-glasses of all ordinary focal lengths, together with carefully detailed instructions for performing experiments in cells, etc., and projecting the enlarged images on the screen.

Induction Coils and Coil-Making. By F. C. Allsop. (Spon.) Illustrated. A large portion of this book has already appeared, in article form, in the *English Mechanic*. Mr. Allsop is, of course, a manufacturing electrician, and his work, as far as technical details are concerned, may be relied upon. The book, however, is not merely a series of lessons on the construction of coils, and batteries for working coils, but it also includes a pretty thorough summary of the literature on these subjects. There are, moreover, chapters on the method of obtaining photographs of electric discharges, and a very understandable description of the X-ray apparatus, together with a simple means of obtaining photographs. A photograph of the author's hand by means of a four-inch coil, with two minutes' exposure, is here reproduced, and it is a very good example of what may be done by means of home-made appliances.

XUM

BOOKS RECEIVED.

Whitaker's Titled Persons, 1897. 2s. 6d.

Dynamo Attendants and their Dynamos. By Alfred H. Gibbings. Third Edition. (Rentell.) Illustrated. 1s.

Celestial Motions. By W. T. Lynn, B.A. (Stanford.) Illustrated. 2s.

Remarkable Comets. By W. T. Lynn. (Stanford.) 6d.

Remarkable Eclipses. By W. T. Lynn. (Stanford.) 6d.

Physical Tables. Prepared by Thomas Gray. (Smithsonian Institution.)

A Study of the Sky. By Herbert A. Howe. (Macmillan.) Illustrated. 6s.

Relics of Primeval Life. By Sir J. W. Dawson. (Hodder & Stoughton.) Illustrated. 6s.

Metals. By A. K. Huntington and W. G. Macmillan. (Longmans.) Illustrated. 7s. 6d.

The Journal of Malacology, 1896. Edited by Wilfred Mark Webb, F.L.S. (Dulau.) Illustrated.

Proceedings of the Academy of Natural Sciences. Edited by E. J. Nolan. (Logan Square, Philadelphia.) Illustrated.

Chapters on the Aims and Practice of Teaching. Edited by Dr. Frederick Spencer, M.A. (Cambridge University Press.)

Practical Electrical Measurements. By E. H. Crapper. (Whittaker.) Illustrated.

Smithsonian Report, 1894, of the U.S. National Museum. (Government Printing Office: Washington).

Our Secret Friends and Foes. By Prof. P. F. Frankland, F.R.S. (Society for Promoting Christian Knowledge.) Third Edition. Illustrated. 3s.

Moths. By. W. F. Kirby. Allen's Naturalists' Library, Vol. IV. Edited by R. Bowdler Sharpe. (W. H. Allen & Co.) Illustrated. 6s.

Short Studies in Physical Science. By Vaughan Cornish, M.Sc. (Sampson Low, Marston, & Co.) Illustrated. 5s.

New Thoughts on Current Subjects. By the Rev. J. A. Dewe. (Elliot Stock.)

Library Year Book, 1897. Edited by Thomas Greenwood. (Cassell.) Illustrated. 2s. 6d.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE CHEMISTRY OF THE STARS.

To the Editors of KNOWLEDGE.

SIRS,—In a note on my article on "The Chemistry of the Stars" in the last number of KNOWLEDGE, Mr. Maunder takes objection to the conclusion that spectral differences are due to different stellar temperatures, seemingly on the ground that it necessitates the "inadmissible" assumption that the chemical elements are distributed in like proportions throughout all the heavenly bodies. So far from regarding the similar chemical composition of all stars as an assumption, I look upon it as a result, which, if, perhaps, not yet absolutely demonstrated by the available evidence, is at least not in contradiction with anything that we know concerning stellar spectra.

In the first place, stars with spectra identical with that of the sun are found in all parts of space—for they are seen in every direction and are of all magnitudes—and in all such cases the evidence is complete, not only that similar elements are in question, but that the absorbing regions of these stars have precisely the same percentage chemical composition.

Again, if the variety of stellar spectra is due to fundamental differences of chemical composition, one would expect to find spectral differences among stars which are at the same temperature. Now, the relative temperatures of the stars (that is, of their most effective absorbing vapours) can be determined with considerable certainty: by the study of the magnesium lines, as Scheiner has shown; or, better still, by the varying representatives of iron at different temperatures, as Lockyer has more recently demonstrated. When this test is applied, the verdict is that stars with equal temperatures do not exhibit any such differences among themselves as to suggest varying chemical compositions.

In these inquiries allowance must be made for the fact that spectroscopic invisibility does not necessarily imply non-existence (as witness the non-reversal of the helium lines in the solar spectrum), and for the changes in metallic spectra at different temperatures. The importance of the latter point is strongly emphasized by the recent work of Lockyer, showing, with great probability, that the two thousand lines of iron seen in the arc spectrum are reduced to nine at the temperature of the hotter stars.* Bearing these points in mind, as well as the fact that a particular stellar spectrum is always associated with a particular temperature, the action of different temperatures upon the same mixture of chemical substances appears quite competent to produce the observed differences in the spectra of the stars.

In only one sense, it seems to me, can it be held that the percentage compositions of stars are different, and that is to admit that in the hotter stars the chemical elements are dissociated, some at one temperature and some at another, so that it would be more correct to distinguish between elements and their germs. Percentage differences of this kind, however, are not fundamental.

A. FOWLER.

[In replying to Mr. Fowler, in order to render perfectly distinct the point at issue between us, I would like to quote the conclusion of an article appearing in KNOWLEDGE for June, 1891. "The types of stellar spectra are not to be explained along one line only, but along two: they do not always denote the phases attained by the stars in their development; they often indicate, instead, radical differences of constitution." I would also repeat what I stated in commenting on his article in the March Number, that his view of the meaning of the relation between the different kinds of stellar spectra "is certainly *one* interpretation which can be put upon that relation, but not the sole one." I do not dispute for a moment—it would be impossible to do so—that difference of temperature condition is in very many instances the true explanation of difference of stellar spectrum. I only challenge it as the sole explanation and as being universally applicable. I cheerfully concede that, in some instances to which Mr. Fowler alludes, the demonstration is as complete as we can reasonably expect with our present knowledge.

I wish to emphasize this point, as it seems to me that Mr. Fowler has fallen into the mistake of supposing that if he can prove spectral type to be an indication of "star age" in several cases, it must necessarily be so in all. The reverse is rather the case. If the hypothesis of the exact equal distribution of the elements is upset in a single instance, it is rendered untenable as a postulate altogether.

I think there are facts which must lead us to this conclusion. I can but briefly summarize some of them here.

If temperature change be the sole cause of difference of type, then it follows that every star must in its turn pass through every single variety of type. None whatsoever can be omitted, no matter how unique and bizarre—unless, perhaps, we except the type of highest temperature, universally supposed to be that of the Sirian stars. To take a very extreme case: Prof. Pickering has just reported to us the discovery of a star of a perfectly new type, *Zeta Puppis*. On Mr. Fowler's assumption, we must suppose that every star in the sky must have shown this curious triple character in the past, or must show it in the future. And the new rhythmical series must belong to some substance present in the same proportions in every single celestial body, but the spectrum of which is developed only at the precise temperature which *Zeta Puppis* and no other known star has reached.

* *Nature*, March 11th, 1897.

We have, then, the case of the "fifth type" spectra, distributed, as is so well known, practically along the galactic equator. Is it possible to conceive that we have one well-marked temperature stage confined to a single great circle of the heavens?

There is another point. A small star will undoubtedly "age" more rapidly than a large one. Consequently, when we have in the same group, and, roughly speaking, at the same general distance from us, stars of very wide range of magnitude, we have the right to expect, on Mr. Fowler's assumption, a very wide range of spectral type. Indeed, in such groups, we might reasonably look for the entire series. The Pleiades is a case in point, and here we find practically but a single type. More striking still, in the Milky Way—the components of which, as the arguments of Proctor, Ranyard, and Sutton have shown, are relatively of no very wide range of distance from us, and where we find with an enormous range of stellar magnitude an immense clustering of very small stars—we have a predominance of the Sirian type. It is just here in the association of large and small stars of the same type in the same cluster that the difficulty consists. We ought to find in such cases the usual evidence of difference of temperature condition, but we do not.

Further, Mr. Monck has shown that there is a marked correlation between the amount of proper motion and spectral type. It is difficult to see how temperature and proper motion are connected.

In conclusion, we must suppose, on Mr. Fowler's assumption, that nebulæ are, like stars, all of the same proportionate composition, and are *all strictly homogeneous throughout*. I merely suggest this point for Mr. Fowler's consideration.—E. Walter Maunder.]

STAR SYSTEMS.

To the Editors of Knowledge.

Sirs,—Mr. Monck's letter, page 72, is an important addition to his letter in Vol. XIX., p. 274, laying down, as it does, the three conditions which he considers necessary before common proper motion can be held to be evidence of physical connection. The two last of his conditions will, I think, be generally accepted, and Mr. Monck's statement that they are not fulfilled in the case of the stars in the Plough is also an important addition to the discussion.

It would, however, be more satisfactory if he would furnish the exact proofs upon which he bases this conclusion, for Proctor's statement with reference to the second condition, "that the correspondence in their motions should be close," is that such is the case with regard to the five stars β to ζ, their apparent motion being unusual and contrary to that of the majority of bright stars. The drawing on page 251 of your Vol. XIX. shows that Proctor is correct with respect to the stars γ, δ, ε, ζ; but he also adds the two stars Alcor, and the one between it and ζ, as having nearly the same motion. This would make six stars within a space of about twelve degrees with the same drift, thus fulfilling the first condition laid down by Mr. Monck, "that the stars be situated within a moderate distance of each other." It is a question, however, whether with our limited knowledge this should be considered a condition, or what the expression, "a moderate distance," can be held to mean. It may be easy to believe that stars at a much greater apparent, and even actual, distance apart than these stars may have a common drift and a common origin.

As regards the third condition, "that the motions themselves be of such a character that only a small proportion of them can be ascribed to errors of observation," Mr. Monck might suitably supply the grounds upon which he believes that the condition is not fulfilled in the case of the Plough.

T. W. Backhouse.

Sunderland, March 17th, 1897.

THE LEAF-CUTTER BEE.

To the Editors of Knowledge.

Sirs,—I am sorry if Mr. Enock considered my reply to his letter in the January Number of Knowledge in any way discourteous, but I would recall to his remembrance that it was he in the first instance who accused me of inaccuracy, and I was in justice to myself bound to reply to his challenge and prove my facts, if I did not choose calmly to submit to Mr. Enock's inference that I had written upon a subject of which I knew little or nothing.

Had Mr. Enock read my letter more carefully, he would have seen that I did not state that I relied solely upon the observations of "well-known scientific men." I have always been in the habit of investigating and proving facts for myself, since the time when I worked under the guidance of my friends and teachers the late Charles Darwin and Prof. Huxley; but I do not altogether ignore and discredit the works of acknowledged authorities, and consider my own observations and opinions as superior to those of anyone else.

Mr. Enock's photograph is certainly remarkable, and it may interest him and others of your readers to see one that I have taken of a cell of the leaf-cutter bee (*Megachile centuncularis*), the insect I described in the November Number of Knowledge. The folding under of the leaves to form the base of the cell may be seen in Figs. 1, 4, 5, and 6.

Photograph of Pieces of Leaves forming a Cell of *Megachile centuncularis*. Fig. 1.—First or Outer Sheath, showing the lower portion folded under to form the Base of the Cell. Fig. 2.—Inner or First Cap, closing the Cell. Fig. 3.—Second or Outer Cap, placed above First Cap. Fig. 4.—Second Sheaths. Fig. 5.—Third Sheaths. Fig. 6.—Inner Leaf.

I quite agree with Mr. Enock that the pudding when made by mother bee is sweet and fragrant, but there is an old saying that "the proof of the pudding is in the eating," and by the time the larva tastes it it has become as I described.

I forgot to mention in my last letter that there are other leaf-cutter bees who construct their cells with pieces cut from the leaves of the willow and the petals of the poppy. Thanking you for the courtesy you have shown in publishing my replies to Mr. Enock's letters,

Francis M. Duncan.

1, Lincol Villas, Gloucester Road, Redhill,
March 15th, 1897.

MIRA CETI.

To the Editors of Knowledge.

Sirs,—Owing to the long-continued spell of weather unfavourable to astronomical work, my opportunities for observing Mira have been very few at this apparition.

The star was plainly visible to the naked eye on November 29th, and has been looked for on every evening since that date when there was the slightest chance of its being seen. It has, however, not been caught sight of for the past six weeks, and will now set too soon after the sun.

According to the observations given below, a maximum occurred on January 23rd or 24th.

1896.	Mag.	1897.	Mag.
November 29	5·2	January 3	4·0
December 7	4·3	„ 14	4·1
„ 12	4·2	„ 22	4·0
„ 18	4·0	„ 23	3·8
„ 19	4·0	„ 25	3·9
		„ 26	3·9

The comparison stars used have been as follows:—

	Mag.		Mag.
75 Ceti	5·6	Delta Ceti	4·1
Nu „	4·9	Alpha Piscium	4·0
Xi² „	4·4		

W. E. Besley.

PHOTOGRAPH OF THE GREAT NEBULA IN ORION.

By Isaac Roberts, D.Sc., F.R.S.

THE photograph of the great nebula in Orion, an enlargement of which to the scale of one millimètre to twenty seconds of arc is annexed, was taken with the twenty-inch reflector; the negative had a dual exposure, with an interval of five days between them—first on the 3rd and the second on the 8th February, 1894—the full exposure being seven hours and thirty-five minutes, and the photograph depicts, very probably, the maximum of extent and detail that can be shown by aid of photographic methods.

This statement is of great importance in astronomical photography, for, if correct, it proves that, as regards duration of exposure, we have already reached the limit of the available aid by this method in astronomical researches. It is therefore essential that I should give my reasons for arriving at this inference; they are the following:—(1) The film of the negative is, in consequence of prolonged exposure to the latent sky luminosity, darkened on development to a degree that would obscure faint nebulosity and faint stars. (2) Longer exposures of the plates would not reveal additional details of nebulosity nor more faint star images.

I am fully aware that doubts as to the accuracy of these statements will be raised, and I will, in anticipation, here refer to some of them. (*a*) An exposure of twenty-four hours fifty-three minutes has been given to a plate upon the region of Eta Argus by Dr. Gill at the Cape Observatory without the film being too densely darkened, and I am under the impression that Dr. Max Wolf and others have given long exposures to plates in portrait-lens cameras, but I have not seen any reports concerning the results bearing upon this question. (*b*) The plates I have used may not have been sufficiently protected from light. (*c*) The nights on which the photographs were taken may not have been normally clear. (*d*) Extraneous light may have somehow affected the film. To all these and to other suggestions of a similar character, I would answer that due and proper care has been exercised in guarding against the occurrence of these contingencies; and that the darkening of the sensitive films, by long exposure to the sky in the twenty-inch reflector, is proportional to the duration of the exposure and the quality of the night—the longer the exposure the darker the film becomes in the development of the images. The sequence here stated has been observed during many years on all very sensitive films which have had long exposure, and found to be practically invariable; at the same time the unexposed margins of the films are *not darkened, but remain clear*.

The reason why a refractor of focal distance to aperture in the ratio of one to ten could not cause the darkening of the film, nor depict faint nebulosity and faint stars, so rapidly as a reflector of the focal ratio of one to five, is consequent upon the greater power of the latter in the concentration of light upon the sensitive film than is possessed by the refractor; there is also loss of light by reflection from the surfaces of the lenses, by absorption, and by absence of perfect achromatism in the lenses. Less sensitive plates may also have been used in the refractor than were used in the reflector, and the development of the plates may not have been carried to the same degree of intensity. Therefore on consideration of all the relative conditions, twenty-five hours' exposure of a plate in the refractor may not be so near the limit of practicable photographic effect as seven and a half hours would be with the twenty-inch reflector.

Many photographs of the nebula here referred to have been taken since the year 1880, when the late Dr. Henry Draper, in America, took the first; and it is regretable that scant justice has been done to his memory as the pioneer of nebular photography. Those who have referred to his work do not seem to have noticed the reproduction of his photograph of the nebula in Orion in Prof. Holden's monograph, published at Washington in 1882, Pl. XL., pp. 226-230. This photograph ought in fairness to be designated the *premier* one, for there is very little difference between it and that taken by Dr. Common in 1883, and I do not think that Dr. Common himself has ever put forth a claim for great advancement in his photograph beyond that by Dr. Draper, taken in March, 1882, and referred to above.

The negative and the positive copy of it on glass, more than the photograph hereto annexed, depict the nebulosity in marvellous detail, and in curdling visible forms—quite indescribable by language—from the extreme boundaries of the cloudlike matter to the dense centre around the trapezium; they also show the structure and extent of the northern part of the nebula (h 1180), together with the vortical faint cloudiness which extends from this part of the nebula to the other, and connects them together; thus pointing to the common origin of the three nebulæ, M 42, 43, and h 1180.

The southern margin of the nebula extends to the star Eta, and is lost in the atmospheric glare that appears like nebulosity surrounding that star.

It would not be profitable at the present time to enter into speculative matters concerning the forces that may have originated this nebula, but it is evident on close examination of the negatives—of which I now have several, taken during the past eleven years—that there are vortical areas within the nebula, and that they curve and trend in various directions: they resemble eddies in whirlpools, or puffs of steam ejected into the atmosphere. There are also several obviously variable stars in different parts of the nebula, but I have not been able to detect with certainty any striking or readily seen change in the structure of the nebulosity shown on the photographs which have been taken during the past seven years. This would indicate that the nebula is at a great distance from

PHOTOGRAPH OF THE GREAT NEBULA IN ORION.

By ISAAC ROBERTS, D.Sc., F.R.S.

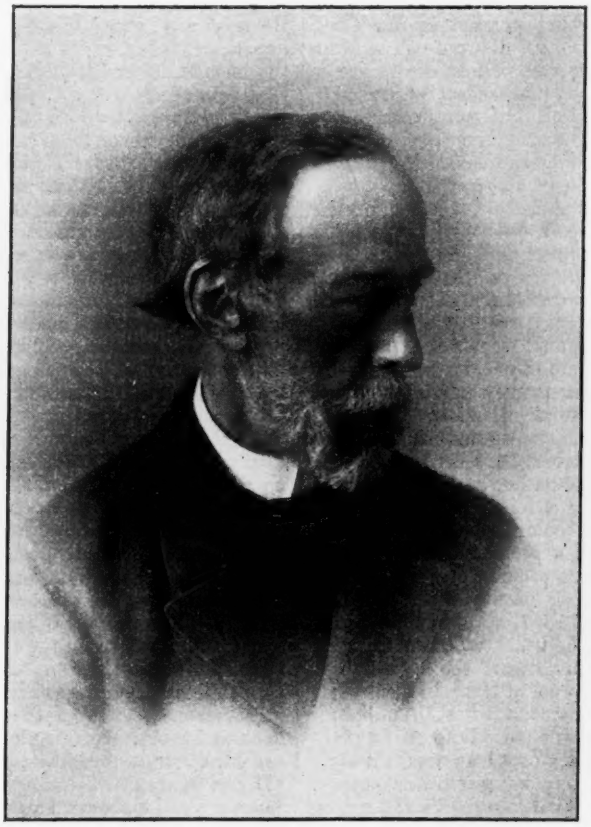
the earth, and that the movements in the interior of the nebulosity are not remarkably rapid.

With the records we now possess of the nebula and of the details of its structure, it will be both easy and certain to detect any change that may take place in it in the future if it should exceed about three seconds of arc in extent.

THE STORY OF A USEFUL LIFE.*

MANY of the great figures of the Victorian era—figures which towered like giants over their rivals for fame in their day and generation—were, in all probability, simply the lucky creatures of circumstance, who enjoyed such exceptional opportunities—holding all the trump cards—that perhaps the most reckless playing in the game of life could not prevent them from winning. On the other hand, it has happened, once in a while, that a great soul circumscribed by every conceivable retarding influence has risen like a phœnix out of the ashes of annihilated foes — foes consumed by the fire of genius sustained at a white heat by steady and persistent effort. The impressionable world of hero worshippers —people who stalk through the diversified avenues of life as mere spectators of the real actors—are now and again arrested in their perambulations by the startling revelations of some fellow mortal, who, it may be, has thought out some of life's problems or solved some of its mysteries.

Time and space form, as it were, the ordinates of human life, of the world, and of the universe. We are all interested in these subjects, which concern us so much and yet convey so vague an idea to our understanding. Our grandfathers stood aghast when the elder Herschel drew aside the curtain and enabled them to perceive the vastness of the universe and to realize the puny dimensions of our own solar system. In our own day we were equally paralyzed with wonder when the late Dr. Croll invented, so to speak, the geological clock, and taught us to measure time, not in minutes and hours, but in millions and tens of millions of years! Seeing how few and short are the days which fall to us here, one may well pause when writing, thinking, and speaking of years by the million.



James Croll, LL.D., F.R.S., etc.
From "Autobiographical Sketch of James Croll, LL.D., F.R.S., etc."

And who was Dr. Croll? Probably most readers of Knowledge will remember him as the world-famous author of "Climate and Time," which made its appearance in 1875; but, beyond the Cheviot Hills, there are many villagers and citizens who only knew him as plain James Croll, an unobtrusive artizan entirely dependent on the labour of his own hands for a living until well advanced in years, and yet by his own unaided efforts he attained to such a high plane of thought as to win the admiration and respect of the greatest philosophers of his time in all civilized nations.

James Croll was born in the parish of Cargill, Perthshire, January 2, 1821, and received only the rudiments of an education. His early science studies were instigated by the fascination with which the *Penny Magazine*, Dick's "Christian Philosopher," and Joyce's "Scientific Dialogues," held his boyish taste for novelty. There was in these out-of-the-way studies no ulterior aim, no guidance or assistance of any kind from anyone—it was diversion pure and simple, and the lad was intended for manual work. In 1837 he was apprenticed to a millwright, and occupied in this rough, rambling life, on an average, three different beds in a week. Later, he found more congenial occupation as a working joiner; but a defect of long standing in one arm being accentuated by an accident, his course was again deflected, and he, in 1846, learnt the mechanical art of weighing and parcelling up tea, serving over the counter, and the usual routine of shop work. As tea merchant he struggled on till about 1850, and then, as a stopgap, he made induction apparatus for use as a curative agent, as electricity and so-called galvanism at that time were exciting much attention. But to the imperative question—how to earn a permanent livelihood—a possible solution now presented itself in the form of a temperance hotel, and we accordingly find him at Blairgowrie, in 1852, making chairs, tables, bedsteads, basin stands, toilet tables, and other articles in order to make a start without sinking hopelessly in debt; but a year and a half was sufficient to show that the hotel would never become self-supporting, and hence, in 1853, he began what proved to be the most disagreeable part of his life—that of an insurance agent—for to one of a retiring disposition like Croll it was venom to his soul to be constantly obliged to make up to strangers. In 1858 he obtained a place in the office of the *Commonwealth*, a Glasgow weekly newspaper, and in the following year he was appointed caretaker of Anderson's College and Museum. After upwards of twenty years of all sorts of hardships

* "Autobiographical Sketch of James Croll, LL.D., F.R.S., etc., with Memoir of his Life and Work." By James Campbell Irons, M.A. (Stanford.) 12s.

and difficulties, this berth, though the salary was small, suited him entirely, and afforded that opportunity for which his thirst for knowledge craved—the free use of a valuable library. Here he read the researches of Faraday, Joule, Thomson, Tyndall, Rankine, Darwin, and others. In the spring of 1864, Croll independently conceived that the change in the eccentricity of the earth's orbit might be the real cause of the glacial epoch—a subject which at the time was being discussed by geologists—and he wrote a paper expressing his views, which was published in the *Philosophical Magazine* for August, 1864. The originality of the ideas advanced attracted much attention, among the men of note who appreciated the new departure being Sir Archibald Geikie, who invited Croll to join the Scottish Geological Survey, on the reorganization of the service in 1867. Croll, who was then forty-six years of age, had to submit to the indignity of being plucked by the Civil Service Commissioners because he did not succeed in totting long columns of figures and writing neatly like a young lad fresh from school; but the wooden rules of red-tapeism were ultimately relaxed on the strong recommendation of Geikie, Murchison, and Thomson, to accept Croll's great calculations regarding the eccentricity of the earth's orbit and the precession of the equinoxes during the last ten million years as sufficient evidence of his capacity for figures, and his papers published in scientific journals as proof of his ability to write tolerable English. He accordingly entered the service on September 2nd, 1867, and for thirteen years conducted the correspondence with the men in the field, supplied them with necessary maps, instruments, and stores, etc., from a central office in Edinburgh—duties which were physically and mentally of a light character, and consequently admitted of his continuing his own private investigations in speculative philosophy. Retiring from active service in 1881, he lingered on till the 15th December, 1890, writing a little as he was able. Such is a brief outline of Dr. Croll's life. He was throughout his career a toiler for daily bread; all his purely scientific work being of the nature of a hobby, and not in any sense a profession or means of augmenting his resources from a pecuniary point of view.

Dr. Croll's first literary work of any pretension was "The Philosophy of Theism," 1857, a volume published anonymously, and the object of which was, not to prove the existence of God, but to investigate the *method* to be pursued in order to arrive at a proof of His existence. It is worthy of note that Dr. Cairns predicted that the unknown writer needed only to give himself entirely to this topic—or any other—to achieve distinguished success, his style being conspicuous for dignity, manliness, and translucency. During the next few years he contributed several interesting papers to the press, which showed that he was busily occupied in thinking out for himself some of the great scientific problems of the day; but it is to the year 1864 that we must look for the initial point in that brilliant career which he ultimately carved out for himself. His scientific papers may be divided into six groups: (1) Early Physical Papers; (2) "Age and Origin of the Sun"; (3) "Geological Climate and Chronology"; (4) "Glacial Epoch and Glaciers"; (5) "Ocean Currents"; (6) Miscellaneous Papers.

A few words from Prof. Tyndall in reply to Croll, who had submitted one of his papers, will convey some idea of the value of the latter's physical investigations:—"Your letter was interesting to me as an illustration of power to seize a definite physical image: the molecules acting as hammers was capital." On another occasion, after sending his paper "On Supposed Objections to the Dynamical Theory of Heat," Croll received this reply: "The very experiment to which you refer, of rendering a body hot by concussion, is the one which most influenced my conviction that it was possible to produce incandescence by invisible rays."

Dr. Croll, in his paper "On the Physical Cause of the Change of Climate during Geological Epochs," summarized the theories then in vogue, and declared them to be insufficient to account for the magnitude of the results. He then discussed the effects of changes in the eccentricity of the earth's orbit, both directly and indirectly, but showed that a lack of data prevented any very definite conclusions being drawn. By means of Leverrier's formulæ, he calculated tables of eccentricity for three million years in the past and one million years in the future, with the view of determining the periods of high eccentricity which, according to his theory, were coincident with cycles of extreme cold. The late Sir Andrew Ramsay was one of the very first to perceive the importance of Croll's paper, and, quite unknown to the author, he wrote, 19th August, 1864: "I have just read your article . . . and am very much struck with your views. . . . If your theory be true, we may have at length some hope of being able to measure geological time. . . . I was delighted to find the statement so plainly put." In the four million years included in Croll's computations three epochs of high eccentricity were apparent, and at the one which occurred eight hundred and fifty thousand years ago he concluded that the Gulf Stream could not have been more than half its present volume. The midwinter temperature of Scotland would be 45·3° F. lower than at present, owing to the greater distance from the sun, while, the Gulf Stream would cause a further diminution of 14° F., giving a total diminution of 59·3 F. below the present midwinter temperature of 39° F. Thus the midwinter temperature of Scotland eight hundred and fifty thousand years ago was −20·3° F. If glacial conditons occur when the eccentricity is great, then there is a possibility of correlating these ice epochs with definite dates; and when the dates of the most recent glacial epochs are fixed, the approximate age of the other epochs and events of the earth's evolution can be estimated.

By another process of reasoning, Dr. Croll studied the origin and age of the sun, and he was disposed to fix the limit at one hundred million years. In seeking to establish the age of the stratified rocks, he based his estimates on the known rates at which the Mississippi carries sediment into the ocean. This fairly typical river removes one foot from the surface of the land in six thousand years. By this process of denudation, continents are cut up into islands, and these again into smaller tracts, till the whole finally disappears. In his "Stellar Evolution," Croll elaborated a theory of the origin of suns and systems which has at least secured the approval of many eminent astronomers, and will find a place in the history of astronomical speculation for long years, if not for all time. In his last work, "The Philosophical Basis of Evolution," he concludes that the universe, in all its beauty, joy, and fulness of life, can never be explained in terms of matter, motion, and force; so that the whole process of evolution, natural selection included, evidently points to Theism. The argument, as far as it goes—so says his biographer—is simply irresistible.

The irony of fate is nowhere more poignantly apparent than in the story of this truly great philosopher's life, as narrated and illustrated by the happily interpolated letters from the most eminent contemporary men of science in these pages. Mr. James Campbell Irons has indeed produced a very realistic picture of a beautiful and useful life—a life which from every point of view was strikingly uncommon, pure, intellectual, noble, and generous. Mr.

Irons concludes his preface to the book thus:—"This volume has been written with the hope that the life of Dr. Croll, recording the triumph over his early struggles, his scientific researches—which secured him a worldwide reputation as an original thinker—and his earnest belief in the Christian faith, may prove interesting. It may only be added that the entire proceeds of its sale will be handed to his widow."

THE FACE OF THE SKY FOR APRIL.

By Herbert Sadler, F.R.A.S.

SPOTS continue to diversify the solar disc from time to time. Conveniently observable minima of Algol occur at 11h. 56m. P.M. on the **11th**, and at 8h. 46m. P.M. on the **14th**.

From the middle of the month Mercury becomes very well placed for observation. On the **16th** he sets at 8h. 30m. P.M., or about 1½ hours after the Sun, with a northern declination of 16° 47′, and an apparent diameter of 6·0″. On the **23rd** he sets at 9h. 13m. P.M., or 2h. 5m. after the Sun, with a northern declination of 20° 54′, and an apparent diameter of 6¾″. On the **30th** he sets at 9h. 30m. P.M., or 2h. 11m. after the Sun, with a northern declination of 22° 57′, and an apparent diameter of 8¼″. He is in superior conjunction on the **2nd**, and at his greatest eastern elongation (20½°) on the **28th**. During the month he describes a direct path in Taurus, being about 1° south of the Pleiades on the **27th**.

Venus is a beautiful object during the first three weeks of the month, but after that she rapidly becomes invisible, being in inferior conjunction on the **28th**. On the **1st** she sets at 10h. 18m. P.M., with a northern declination of 22° 45′, and an apparent diameter of 44″, about $\frac{2}{16}$ths of the disc being illuminated. On the **11th** she sets at 9h. 43m. P.M., with a northern declination of 23° 17′, and an apparent diameter of 51″. On the **21st** she sets at 8h. 38m. P.M., with a northern declination of 21° 43′, and an apparent diameter of 57″. While visible she describes a short looped path in Aries.

Mars is visible, but his disc is now so tiny that hardly any details can be made out on his surface. He will be occulted by the Moon on the morning of April **9th**, but the phenomenon will hardly be visible in this country. On the **1st** he sets at 2h. 15m. A.M., with a northern declination of 25° 28′, and an apparent diameter of 6¾″. On the **30th** he sets at 1h. 15m. A.M., with a northern declination of 23° 43′, and an apparent diameter of 5½″. During the month he describes a direct path in Gemini, being very near ϵ Geminorum on the **8th**.

Jupiter is still an evening star, and is very well situated for observation. On the **1st** he rises at 2h. 25m. P.M., and souths at 9h. 33m. P.M., with a northern declination of 12° 17′, and an apparent diameter of 43½″. On the **16th** he rises at 1h. 22m. P.M., and souths at 8h. 31m. P.M., with a northern declination of 12° 33′, and an apparent diameter of 41¾″. On the **30th** he rises at 0h. 25m. P.M., and souths at 7h. 35m. P.M., with a northern declination of 12° 33′, and an apparent diameter of 40″, the phasis on the *f* limb amounting to ⅓″. During the month he describes a short retrograde path in Leo, a little to the east of Regulus.

As Saturn does not rise until nearly 9 P.M. at the end of the month we defer an ephemeris of him till May, and the same remarks apply to Uranus.

Neptune has practically left us for the season.

Shooting stars are fairly plentiful in April, the best marked shower being that of the Lyrids, with a radiant point in R.A. 18h. +33°. The radiant point rises on the **19th and 20th**, when the maximum occurs, about 6½h. P.M., and souths about 4h. A.M.

The Moon is new at 4h. 24m. A.M. on the 2nd; enters her first quarter at 8h. 27m. A.M. on the 10th; is full at 6h. 25m. A.M. on the 17th; and enters her last quarter at 9h. 48m. P.M. on the 23rd.

Chess Column.

By C. D. Locock, B.A.Oxon.

Communications for this column should be addressed to C. D. Locock, Burwash, Sussex, and posted on or before the 10th of each month.

Solutions of March Problems.

No. 1.

(By P. G. L. F.)

Key-move.—1. B to Kt7.

If 1. . . . K to B5, 2. Q to Qsq, etc.
1. . . . K to R7, 2. Q to B2ch, etc.
1. . . . K×P, 2. Q to Kt2, etc.

No. 2.

(By Eugene Henry.)

1. Kt to B2, and mates next move (one dual).

Correct Solutions of both problems received from Alpha, J. T. Blakemore, Captain Forde, W. J. Ashdown, H. Le Jeune, H. H. Thomas, E. W. Brook.

Of No. 1 only from A. P. Hyatt, Sigma, H. W. Elcum, M. Wiedhofft.

Of No. 2 only from W. H. Lunn, G. G. Beazley, W. Clugston, J. M'Robert.

A. P. Hyatt.—If 1. Kt to Kt5, P to K5.

W. H. Lunn.—There is no dual after 1. . . B to B3.

Sigma.—If 1. Kt to K7ch, B×Kt.

H. W. Elcum.—No. 2 was a two-move problem.

M. Wiedhofft.—Your solution is accidentally destroyed. It was, at least, clerically incorrect.

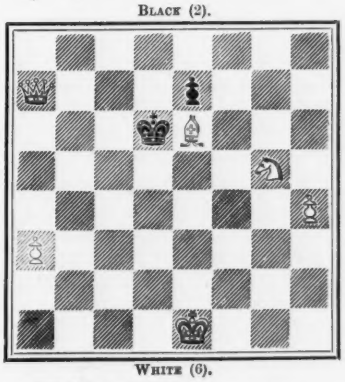
W. J. Ashdown.—Many thanks for the three problems, which shall be examined.

PROBLEMS.

No. 1.

By Philip H. Williams.

Black (2).



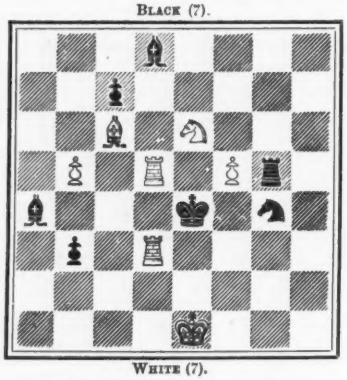
White (6).

White mates in three moves.

No. 2.

By A. C. Challenger.

Black (7).



White (7).

White mates in two moves.

[Mr. Challenger informs us that his problem is a revised and improved version of a position published in another column about a year ago.]

CHESS INTELLIGENCE.

Additional results at the Hastings Chess Festival are:—Messrs. Gunsberg and Colborne won their adjourned game against Messrs. Blackburne and Chapman. Mr. Bird's simultaneous score was: won 13, drawn 8, lost 3. Mr. Gunsberg won 22, drew 7, and lost 2. Messrs. Bird and Womersley won their consultation game against Messrs. Blackburne and Aloof. On February 18th Messrs. Blackburne and Jenour won an Evans Gambit from Messrs. Bird and Trenchard. In the evening, Messrs. Bird, Blackburne, and Gunsberg each played three games against combinations of players in consultation. Mr. Blackburne won his three games; Mr. Bird won two and drew one; Mr. Gunsberg won one, drew one, and lost one (to Captain Gardiner, Messrs. Locock and Mann). There were many other interesting games not on the official programme.

The Sussex Chess Congress began on February 25th. The feature of the meeting was the unique performance of Mr. Lasker, who played thirty-nine games simultaneously, winning them all in less than five hours. The Championship of Sussex was won by Mr. E. G. Reed, Mr. H. W. Butler being second; an Open Tournament being won by Mr. J. H. Blake, of Southampton. Mrs. W. J. Baird won the Ladies' Tournament without losing a game.

We are glad to be able to state that the rumour of the death of Mr. A. F. Mackenzie, the famous problem composer, is entirely devoid of foundation. Mr. Mackenzie has lost his eyesight, but, so far from being dead, he is busily engaged in composing chess problems.

There does not appear to be any great improvement in the unfortunate mental affliction from which Mr. Steinitz is suffering. He is still under careful treatment at Moscow. He, too, has been honoured by many premature obituary notices in the daily press. Mr. Lasker ascribes his condition to injudicious medical treatment, and not in any way to disappointment at the result of their recent match.

A match for the Championship of America is now being played between H. N. Pillsbury and J. W. Showalter. The first two games were drawn, but Mr. Pillsbury won the next three.

The Ladies' International Tournament will be held at the Hotel Cecil, beginning on June 22nd. The prizes are on the scale of an ordinary international masters' tournament.

The following brief consultation game was played at the Hastings Festival:—

"From Gambit."

White. (H. E. Bird and H. E. Dobell.)	Black. (I. Gunsberg and C. D. Locock.)
1. P to KB4	1. P to K4
2. P×P	2. P to Q3
3. P×P	3. B×P
4. KKt to B3	4. P to KKt4
5. P to QB3	5. P to Kt5
6. Q to R4ch	6. Kt to B3
7. Kt to Q4	7. Q to R5ch
8. K to Qsq	8. P to Kt6
9. P to QKt3 (?)	9. Q×P
10. Kt×Kt	10. Q×R
11. K to Ksq	11. Q to Kt8
12. Kt to K5ch	12. P to B3
13. Kt to Q3	13. B to KB4
14. P to K4	14. Castles
15. P×B	15. Kt to B3
16. K to Q3q	16. Q×Bch
17. K to B2	17. Q×BP and wins.

Later.—The *Standard* announces that Mr. Steinitz is now well enough to leave for Vienna.

KNOWLEDGE, PUBLISHED MONTHLY.

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Three Plates.—1. Map of Africa, as published in 1837; Map of Africa, indicating the more important Modern Discoveries. 2. Glory Pea (*Clianthus Dampieri Marginatus*. 3. Stellar Spectra.

NOTICES.

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